# Designing Institutions and Health Education Interventions for Sustainable Supply of Safe Water in Urban Informal Settlements: The Case of Kenya

by

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ABSTRACT

Diarrheal diseases caused by poor water, sanitation and hygiene continue to kill more children in Sub-Saharan Africa's burgeoning informal urban settlements than in any other part of the world. In recent years, Delegated Management Model (DMM), a partnership in which a utility delegates service management to slum residents have been promoted as new models to improve services.

This dissertation examines the benefits of DMM by comparing water services in three informal settlements in Kisumu city, Kenya: two slums where DMM has been implemented, and one, a control, where it has not. In addition, the research examined how school-based hygiene interventions could be designed to improve safe water and hygiene knowledge in urban informal settlements. This study compared outcomes of two approaches to hygiene education, one which combined messages with participatory water testing; the second used hygiene messages alone.

Results of the DMM study showed that DMM implementation had lowered water cost and improved provider accountability. However, unhygienic water collection and handling practices on the part of the service users could contaminate drinking water that was clean at the delivery point, thus preventing the intended health outcomes of DMM from being realized. Results of the hygiene education intervention showed that one week after the inventions, hygiene knowledge among students who received the intervention that combined hygiene messages with participatory water testing was significantly improved. Evaluation of the intervention 12 months after implementation showed that the hygiene knowledge gained was sustained.

The research findings suggest that: i) regular monitoring of water quality at the kiosks is essential to ensure that the DMM model achieves intended health outcomes, ii) sanitation conditions at kiosk sites need to be regulated to meet minimum hygiene standards, and iii) customers need to be educated on safe water collection and storage practices. Finally, school-based hygiene education could be made more effective by including hands-on water testing by students. Making sustainable impact on health and wellbeing of slum residents requires not only building effective partnerships for water delivery, but also paying close attention to the other points of intervention within the water system.

DEDICATION

I dedicate this work to my children Victor and Victoria, who had to endure my very difficult schedule as a student. I further dedicate this work to my wife Gladys, who stoically endured long periods of juggling childcare, household chores, and work during the summer, when I travelled to Kenya collect data, while herself pursuing a graduate degree.

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# CHAPTER 1

## INTRODUCTION

Sub-Saharan Africa (SSA) currently has the fastest growing population in the world (UN-Habitat, 2010). Most of this population growth is being absorbed in urban areas, specifically within overcrowded informal settlements, where the capacity of governments to provide basic services is being overwhelmed by the scale of growth (UN-Habitat, 2010). Centralized approaches to urban water supply have proven to be seriously deficient, and diarrheal diseases continue to kill more children in urban informal settlements in sub-Saharan Africa than in any other part of the world.The problem of access to safe water in this region is expected to worsen in the coming 20 years due to rapid urbanization, burgeoning slums, and increasingly variable patterns of rainfall reliability and distribution associated with climate change (Oosterveer, 2009; Parnell & Walawege, 2011).

During the last fifteen years, the idea of partnership between entrepreneurs and utilities has attracted attention. Oosterveer, (2009) contends that the scale, rate and processes driving urbanization, particularly in SSA, require pragmatic solutions beyond conventional approaches to urban water supply. It has been suggested that partnerships between utilities and small-scale independent providers can accelerate provision of safe water (Lundqvist et al. (2003). In this dissertation I examine how the Delegated Management Model (DMM), in which a utility delegates management of infrastructure and service distribution to slums dwellers, functions and how such partnerships benefits slum dwellers. I compare services in two slums in Kisumu city where DMM has been implemented and one where it has not.

1.1 Challenges of accelerating safe water provision in SSA

Slow progress in government provision of safe water in towns and cities in sub-Saharan Africa has been blamed on rapid population growth, lack of infrastructure, limited water sources, and poor governance (Brookshire & Whittington,1993; Showers, 2002; Bruggen at al. 2009). Rapid population increase poses a threat to water resources because cities have to increase water extraction to meet the demands of an increasing population; for example, water resources in Haromaya, Ethiopia, and in Lake Chad have dwindled to extraction to serve urban populations (Bruggen at al. 2009). Climate change may further complicate the capacity of SSA to meet rapidly rising urban water supply demands. According to Showers (2002), two-thirds of the African continent will be water stressed by 2025. Already: i) water is less available on the Africa continent that any other region in the world, ii) population increases will further reduce per capita water availability, and iii) conflict or cooperation might result in the future as national and international completion for the scarce water resource worsens (Showers, 2002). Conflicts over water resources have been reported in several countries; for instance, Kenya and Ethiopia are in conflict over the shrinking of Lake Turkana (Powers et al. 2011). Most towns lack not only water but also wastewater treatment systems, so they face a double dilemma: they have little water to begin with, and what little they have, they pollute. Huge volumes of wastewater end up contaminating ground water, rivers, and coasts, a situation that is not sustainable (Showers, 2002; Lundqvist et al. 2003).

The nature of urbanization poses other challenges to safe water coverage within cities and towns (Lundqvist et al. 2003). Because of poverty and inequality, urban growth in most parts of the sub-Saharan region takes the form of proliferation of informal urban settlements (UN-Habitat, 2008); more than 60 percent of urban dwellers in Sub-Saharan Africa live in such settlements (UN-Habitat, 2010). Most informal settlements do not comply with building standards and planning regulations. This makes water distribution in urban informal settlements difficult because utilities do not want to extend service to dwellings that are likely to be demolished (K'akumu, 2004). Consequently, diseases related to poor water and sanitation kill more people in urban slums in

SSA than anywhere else in the world, especially children (WHO, 2010). In many urban settlements, a majority of residents rely on cheap, unregulated, and unsafe water sources to meet their water needs. These sources include water vendors who use water trucks or animal- or human-drawn carts to deliver water. Although the pricing and quality of water from these sources is highly contested in the scholarly literature, the sources nevertheless meet a pressing need. Inadequate urban water supply not only has negative health effects, but harms people in other ways: is prevents children from going to school and women from engaging in income-earning opportunities. Collecting water is typically the job of women and children (Nicol, 1998; Bartlett, 2003). Many children, usually girls, spend long hours each day collecting water, which interferes with their school attendance (Doyle, 1995). Moreover, girls are commonly assaulted along their way to collect water, raped or even abducted (UN-Habitat, 2008). Thus, lack of access to safe water violates children's rights – not only to survival and health but also to optimal development and a decent standard of living according to the UN - Conventions on the Rights of the Child, Articles 6, 24 and 27 (CRC,1989). Hauling water increases the already heavy burden of domestic tasks that Kenyan women have to undertake, and consumes time that these women might otherwise devote to income-earning activities (UN-WWAP, 2006). Therefore, increasing water coverage will help women and children and increase educational attainment, so that both present and future generations will benefit.

### 1.2 Strategies for accelerating national coverage of safe water

Three approaches have been suggested to accelerate service provision: 1) externally driven approaches by donor agencies, usually heavily subsidized; 2) self-supply initiatives (driven by user demands); and 3) enterprise-driven approaches, in which local private entities supply services to users (Solo, 1999; Mitnz et al. 2001; Schaub-Jones, 2008). The idea of encouraging small-scale entrepreneurs to become involved in urban water and sanitation provision, especially in slums, has attracted attention from scholars (Solo, 1999; Schaub-Jones, 2008), and the merits and draw-backs of these providers have been examined in the literature (Solo, 1999). Lundqvist et al. (2003) argue for formal recognition of small-scale providers because they meet a real need

of the urban poor in developing nations. According to Ka'kumu (2004), Kenya's Water Act fails to recognize alternative suppliers who are important to the poor. Some efforts have been made during the past 15 years to promote private-sector involvement in the extension of water service coverage to urban slums (Ka'kumu, 2004). While the private sector can provide expertise in consultancy, supervision, and capacity building, their investments in extending supply to informal urban settlements have produced unsatisfactory returns and opposition from scholars and practioners. Budds and McGranahan (2003) argue that promotion of privatization by international agencies is not grounded in real experiences from the water and sanitation sector, and therefore cannot be a solution to the problem of poor access to water in Africa. This is especially the case because the majority of without access live in low-income settlements, areas in which private for-profit operators do not want to invest.

The push for privatization has gone hand-in-hand with a push for decentralization of water supply to increase safe water coverage (Rondinelli, 1991). Involving communities in service provision is expected to help achieved sustained functioning of infrastructure and supply of water (Rondinelli, 1991). Those who take this view identify the obstacles to community water-supply systems as: lack of adequate incentives, lack of sufficient skills and resources, inappropriate processes for water-system operations and maintenance, ineffective inter-organizational relationships, inappropriate technology, ineffective systems of monitoring, and lack of evaluation and feedback. But others point out that communities lack the capacity to develop and maintain water infrastructure, which is complicated and expensive (Jaglin, 2002). While Isham & Kahkonen (2002) have found that *rural* water-user groups are likely to succeed in communities with cohesive community groups and regular civic activities, it is difficult to form such communities in informal urban settlements because residents are highly transient (Naidoo et al., 2008).

Since 2000, the idea of partnership between small-scale providers and utilities has attracted attention (Lundqvist et al., 2003; Njiru, 2004). Oosterveer, (2009) has argued that, given the scale, rate, and processes driving urbanization, particularly in sub-Saharan Africa, pragmatic

solutions, not conventional approaches, are required to accelerate safe water coverage to the urban poor. One such solution is partnership between utilities and slum dwellers (Lundqvist et al. 2003).

I studied the water-service partnership operating in Kisumu, Kenya, which aims to increase access to safe water in the city's informal settlements. In this partnership, the water utility, KIWASCO, provides a single water-supply line from which master operators are licensed to run secondary supply lines into the settlements. Master operators may be individuals or formally registered community groups. The master operators then allow small-scale vendors to tap into the lines to provide water for sale at individual water kiosks. Settlement residents purchase water at these kiosks for use in their households. These institutional arrangements create four levels at which decisions are made that affect the success of the system, and the degree to which residents have access to an adequate supply of affordable, safe water. The levels are utility, master operator, kiosk operator, and water customer.

1.3 Sites and services: the potential for DMM to improve water services

Sites and services projects aim to provide the urban poor with serviced lots and harness the energies of the communities to build their own houses. These projects are usually supported by donor agencies who provide governments with the money to buy land and instal basic infrastructure (for instance, sewerage network). The serviced plots are then sold to the urban poor. The communities who benefit from such projects may be encouraged to partner with utility through models such as the DMM for service provision. Organizing DMM as a mechanism for providing services from the very start in these projects may result in more desirable service delivery than intervening later when the slum is already established and initiating change is difficult, given conditions of overcrowding and unhygienic conditions that are characteristic of slums. Such innovation may facilitate better services by the informal small-scale independent services providers who typically emerge to provide water and sanitation services to the urban poor. Thus, there is potential to harness the innovativeness of the urban poor if partnerships such

as DMM are conceived and integrated with the broader goals and implementation of the sites and services projects.

However, proliferation of slums will continue to characterize urban growth in the Sub-Saharan region in the next coming three decades, and most of the informal settlements are likely to emerge in difficult terrain, steep slopes, and swampy areas. It has been argued that “the solution to deal with such slums is not to demolish….but to improve the environment: if governments can rid existing slums of unsanitary human waste, inadequate of polluted water and litter and filth muddy unlit lanes, they need not worry about shanty dwellings” (Werlin, 1999, p.1523). As the author further observed, slum communities exhibit a great deal of self-organization and collective action in managing land, and government could trust them to maintain infrastructure provided to them (Werlin, 1999). The initiative by KIWASCO to design and implement DMM to increase accessibility to water services in Kisumu’s slums seems to fit Werlin’s suggestions. Relocating slum communities can be an expensive undertaking (Otiso, 2000); and arrangements such as DMM may offer an alternative to ensure that the urban poor have access to services.

### 1.4 Analytical framework for partnership outcomes

Different scholars have used different frameworks to assess water-delivery partnership outcomes. Tulder and Pfisterer (2008) developed a framework, based on a standard input-output model, for analyzing partnerships. The framework consists of three blocks: input (goals, motives, and resources of individual partners), throughput (functioning of the partnership), and output (results achieved by the partnership). This framework seems to assume linear relationships between inputs, throughput, and outputs (partnership performance). But linear relationships are rarely so clear cut in water-supply interventions.

Other frameworks consider contractual, political, legal, financial, socio-cultural, or technical dimensions as the most important factors in determining partnerships outcomes (Nyarko et al., 2011). Brinkerhoff’s (2002) approach identifies contractual relationships as the key to outcomes. The author argues that contractual elements, namely, trust, efficient reporting mechanisms, and

confidence, are critical to a partnership's capacity to deliver services. Hastings (1999) examined how power relationships among partners can affect partnership outcomes. Other authors (e.g., Caplan et al., 2007) have focused on understanding how the relationships among accountability, transparency, and compliance with contractual arrangements influence outcomes. Mcuaid (1994) examined how partnership outcomes were influenced by the partnership's aims and objectives and the arrangements among partnership groups. The legal framework can also be an important factor influencing service delivery (Akintoye et al. 2003). The legal structure, including national legislation, regulations, and policies, has a profound impact on how partnerships evolve and function; thus, they affect service delivery. Matous (2013) found that a change in service provider, mandated by legislation, led to the collapse of a community water-delivery system in Manila.

Various studies have focused on how community-level social characteristics influence partnership water-service delivery (e.g., Acutt et al., 2001). Insufficient consideration of cultural and social factors in partnership design and implementation can have profound impacts on outcomes, especially on the prevalence of vandalism and sabotage (Acutt et al., 2001). These activities can exacerbate conflicts over infrastructure maintenance. Unfortunately, slum populations are very diverse and most slums dwellers are pre-occupied with survival; thus, even when partnerships are designed to engage beneficiaries in water provision, they can fail because the urban poor do not have the time to participate (Jaglin, 2002).

Other studies focus on the interactions between the technical and social dimensions of water supply, and how these factors influence partnership outcomes (Akintoye et al., 2003). Technology and the condition of infrastructure can impede effectiveness and functioning of water systems. Slums usually proliferate in areas unsuitable for urban development, for instance, on steep slopes or near swamps. The technology and engineering required to supply water to such areas may be beyond the financial capacity of many utility-community partnerships.

The dimensions discussed above fit well into the framework of urban water supply as a socio-ecological system, as proposed by Aggarwal and Haglund (2012). All the above frameworks ignore how water resource availability and characteristics influence partnership type and

outcomes. Nyarko et al. (2011) reported that partnerships between utilities and communities to supply water in small towns in Ghana were ineffective during the rainy season because most customers preferred to harvest their own water. Aggarwal and Haglund's (2012) framework provides a way to bring together the findings in these different streams of literature and examine their inter-relationships. Their framework consists of the following four subsystems: Water resources and infrastructure, settlements, water and urban governance, and actors (Figure 1.1). The framework is helpful in understanding these different sub-systems and their associated variables, and the interdependencies among the different components of the water-supply system and the feedback mechanisms that lead to varying outcomes. I adopted this framework to understand how different factors affected the services in the two settlements where DMM has been implemented (Figure 1.1). I measured partnership outcomes using provider accountability, water pricing, and service reliability.

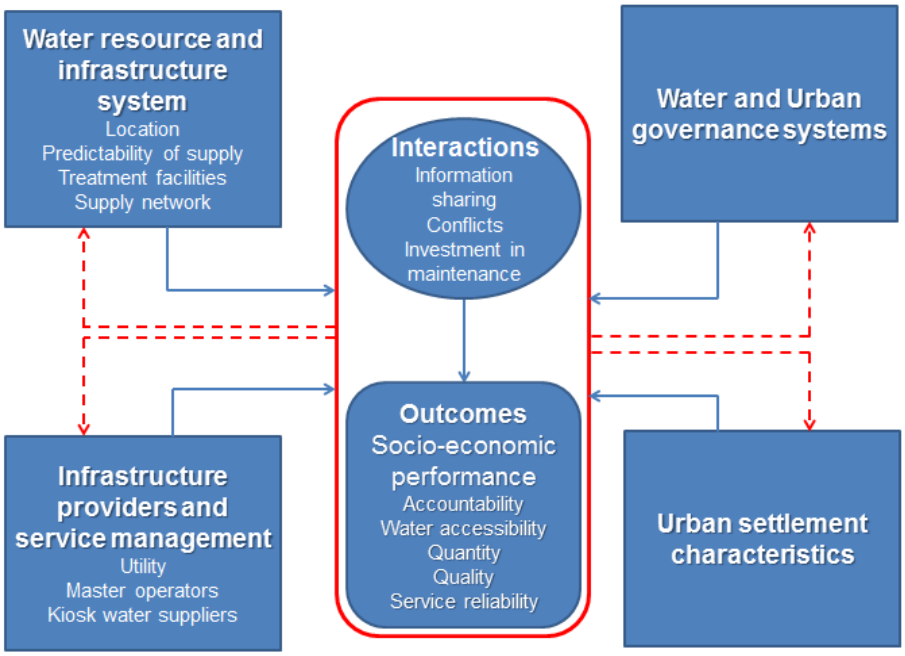


Figure 1.1 Relationships among the factors in water-supply in urban informal settlements. Adapted from Aggarwal and Haglund (2012)

In Chapter Two of this dissertation, I examine the experiences of water kiosk operators with the DMM. Data were gathered using in-person interviews. Interviews were complemented with participant observation and secondary reports. In Chapter Three, I examine how households have benefitted from DMM partnerships. Data were gathered through in-person interviews. In Chapter Four, I examine how school-based hygiene interventions can be designed to improve hygiene knowledge outcomes among schoolchildren.

# CHAPTER 2

# BUILDING PARTNERSHIPS TO IMPROVE WATER SERVICE TO THE URBAN POOR: CHALLENGES OF THE DELEGATED MANAGEMENT MODEL IN KISUMU CITY, KENYA

## 2.1 Introduction

It is estimated that a third of the urban population in developing nations lives in the informal settlements (UN-Habitat, 2013). Africa has the fastest growing urban population in the world (UN-Habitat, 2010). Close to 70% of urban dwellers in Sub-Saharan Africa live in informal urban settlements, the highest percentage in the world (UN-Habitat, 2013). Governments in the region have limited capacity to expand services rapidly enough to keep pace with population growth. Their centralized approaches are overwhelmed by the rate, scale, or form of urbanization. This is especially true in the rapidly growing informal settlements where water service provision by state utilities is inadequate and/or unreliable and residents largely depend on independent service providers. Independent providers are usually entrepreneurs who live in the informal settlement and operate without the formal consent or support of the municipality (Lundqvist et al. 2003). While the cost and quality of water from independent providers have been questioned (Solo, 1999; Lundqvist et al. 2003; UN-Habitat, 2006;UNDP, 2011), it is widely acknowledged that independent service providers play an important role in distributing water to areas and groups of people outside the reach of the utility system, particularly in slums (Solo, 1999; Lundqvist et al. 2003). Informal water providers range from those who use wheelbarrows, bicycles, animal carts, motorbikes or trucks to supply water, to those who establish and operate small piped networks (Solo, 1999; UNDP, 2011).

Since 2000, governments and donors have increasingly encouraged utilities to develop partnerships with independent providers to increase service provision and water quality and affordability (Lundqvist et al. 2003; Njiru, 2004; Oosterveer, 2009; WSP, 2009). One kind of partnership is the Delegated Management Model (DMM), in which a utility delegates

management of infrastructure and service delivery to slum residents (WSP, 2009). The expected benefits of such partnerships include reduction in unaccounted for water, improved access to safe water, increased opportunity for slum dwellers to earn income, and better, cheaper water service. In this chapter, I evaluated the benefits of DMM by comparing service provision by water kiosk providers in three slums in Kisumu city, Kenya, two where DMM has been implemented, and one where it has not. I test for the hypothesis that DMM has produced tangible, measurable benefits in the two slums where it has been implemented, in terms of one or more of the following: water cost, water availability and reliability of service.

## 2.2 Constraints to service provision and opportunities for partnerships

Informal urban settlements vary in size and structure, but typically take one of three forms: large-scale and concentrated, scattered pockets, or illegal subdivisions (UN-Habitat, 2003). Some attributes are common to all informal settlements. These include poverty, social exclusion, lack of secure tenure, lack of access to basic services (water, sanitation, waste collection, electricity), overcrowding and high density, unhealthy living conditions, and hazardous locations (UN-Habitat, 2003).

Public and private water utilities are constrained to expand provision of goods and services to informal settlements by many factors: physical, technical, economic, financial, structural, and institutional (Solo et al. 1993; Solo, 1999; Hunter et al., 2010; and Lundqvist, et al. 2003). Poor people cannot afford to live in formal urban settlements, so they tend to settle on land that is not suitable for urban development, for example in poorly drained lowland areas or on very steep terrain that has been avoided by developers because of high development costs (Solo, et al. 1993). Informal settlements tend to be crowded and to develop haphazardly, without leaving sufficient space for water lines (Solo et al., 1993). Therefore, the cost of conventional engineering to extend piped-water services to these settlements is high, and utilities avoid doing so. Where informal settlements sprout on land suitable for development, they tend to be illegal, and often become targets for demolition by municipal authorities (Akbar et al., 2007). Utilities and private

water companies do not want to risk investing in service infrastructure in illegal settlements (K'akumu, 2004). Governments that are struggling to raise revenue tend to allocate insufficient resources for utilities to extend water infrastructure. And the utilities fear that revenues from informal settlements will be low, perhaps even insufficient to cover the utility's cost of service (Hunter et al. 2010). This fear explains why efforts to get private water companies to accelerate service coverage have failed miserably (Budds & McGranahan, 2003).

Structural constraints are major barriers to utility service in informal urban settlements. Most informal settlements are either illegally occupied or subdivided, and do not comply with building and planning regulations (Solo et al., 1993). Thus there are no official, registered land owners to whom water utilities can offer services (K'kumu, 2004). Some scholars have however argued that institutional constraints pose significant challenge to improving services in informal urban settlements (Rondinelli, 1991; Solo et at., 1993). Most developing countries have a history of inefficient and ineffective water governance (Solo et al., 1993). In many cases, the state has been both the manager of water resources and the supplier of water services (Rondinelli, 1991). This has made it possible for water development to be politicized, and for the political class to engage in rent seeking and manipulative tactics, all of which interfere with the efficient extension of water coverage. And while in the developed world much of the early drive to provide safe water and sanitation came from the medical community, in the developing world the task has largely been left in the hands of the water sector (Hunter et al., 2010). While the health sector benefits from improved water-service provision, utilities alone bear the costs of providing water (Hunter et al., 2010). Given the constraints and history discussed above, it is perhaps no surprise that utilities have failed to meet the need for water services in Africa's informal urban settlements. However, individual water suppliers (or small-scale private water suppliers (Solo, 1999) have found ways of overcoming some of the constraints posed by informal settlements, and even thrived by providing services to slum dwellers (Solo, 1999). These suppliers can be more flexible than a utility, for example by pricing water opportunistically according to water source, distance to market, quantity supplied, and target client (Solo, 1999; Lundqvist, et al. 2003). They employ

diverse delivery technologies and thus are able to traverse even the most difficult engineering terrains (Solo et al. 1993). Whereas utilities worry about collecting payment, individual suppliers usually reside in the same neighborhoods as their clients, and can negotiate different payment arrangements with different clients, and follow up on the arrangements (Solo, 1999). Because most suppliers are in constant touch with customers, they know customer habits and needs, and can diversify to provide other services (e.g., products for treating and storing water, toilets for pay, fuel wood). Stiff competition for customers often improves the quality of services (Solo, 1999). A private supplier's business can grow with demand; some even provide water to formal settlements during water shortages (Solo, 1999). Private suppliers tend to be innovative in introducing new technologies, marketing their services and coming up with new ways to administer services (Solo, 1999).

Utilities, however, complain that some individual suppliers steal utility water and damage infrastructure (WSP, 2009). Water companies in towns and cities all over Sub-Saharan Africa report loss of over 70 percent of potential revenues in the form of "unaccounted for water" (Kayaga & Smout, 2007; Keener et al. 2009). Some informal water providers desperate to meet the rising demand in the growing informal settlements siphon water from utility lines; utilities lose revenue from illegal connections which also add to utilities' costs of maintenance of the infrastructure (Solo, 1999; WSP, 2009). Kayanga and others (2006) estimated KIWASCO's non-revenue water in 2003 to be 70% of the total systems input. According to the authors, the big fraction of the loss was due to water theft and illegal connections (Kayaga et al. 2006). To reduce losses through unaccounted for water, donors and government agencies have encouraged partnerships between utilities and informal service providers (WSP, 2009). In these partnerships, the utility delegates managements of infrastructure and service delivery to slum residents. This arrangement is expected to improve quality of service, lower the cost of water, and provide jobs (WSP, 2009). According to Keener et al. (2009), partnership between a utility and a community master-operator or private operator works well when the utility or some external agency monitors service-delivery performance. But when an external agency handles monitoring and oversight, it adds to delivery costs, which may be passed on to customers.

Donors and government agencies assume that making informal water providers partners in water-service provision increases providers accountability to customers. But, "Where there is not enough social cohesion, strong local power structures and no oversight from a supporting institution, the model can also lead to corruption and mismanagement" (Keener et al. 2009, p. 37). Most people who live in informal urban settlements are highly mobile and preoccupied with rudimentary survival needs; in such transitory communities, social cohesiveness can be elusive (Keener et al. 2009). Lack of social cohesion creates a vacuum that is often filled by corruption. Schwartz and Sanga (2010) have reported corruption problems in some of the network extensions managed by community master-operators in Nyalenda B. Corruption can undermine trust among actors within the partnership, adversely affecting quality of service and customer satisfaction.

I evaluated how DMM had improved services to the urban poor by comparing service management, water pricing, and provider accountability in three slums in Kisumu city, two where DMM has been implemented (Nyalenda A and Nyalenda B), and one where it has not, (Manyatta B). There were differences in the way the utility implemented DMM in Nyalenda A and B. In Nyalenda A, three of the four master operators are private individuals, and only one is a group operator. In Nyalenda B, all of the master operators are community groups. Thus, the study further examined whether there were differences in outcomes between the two settlements with DMM.

## 2.3 Methods

### 2.3.1 Description of study area

Kisumu is Kenya's largest city on Lake Victoria, and the first to implement a large-scale water intervention in informal settlements using utility-community partnership arrangements. Kisumu has a larger proportion of its population living in informal settlements than any other East African urban area on the shores of Lake Victoria, and it is the fastest growing city in Kenya. Its population has grown from 100,000 at the country's independence in 1963 to over 500,000 in 2009; KNBS, 2009). Over 70 percent of residents live in informal settlements (Karanja, 2010), and slightly more than 50 percent of all Kisumu residents have access to piped water. Kisumu's main source of water is Lake Victoria. Rapid urbanization and poor sanitation make Kisumu one of the leading polluters of Lake Victoria. Ground water sources in most parts of the city are contaminated due to the use of pit latrines, the type of sanitation used by most residents (Iro & Long-Cang, 2000; KNBS, 2009).

Water-service provision in Kisumu and other towns around Lake Victoria is the responsibility of the Lake Victoria Service Board (MWI, 2007). The Board owns most of the water assets and infrastructure that water companies lease to provide water to cities and towns. It has agreements with Kisumu Water and Sewerage Company (KIWASCO), a water company formed in 2003, to supply water in Kisumu (Wagah et al. 2010).

KIWASCO partners with small-scale water providers to increase water-service coverage in Kisumu's informal settlements. Except for Nyalenda A and B, where the DMM has been implemented, residents in all the other informal settlements (as individuals or community groups) can apply directly to the utility to sell water. In both Nyalenda A and B the utility, with support from donors, has implemented a different model where more of the responsibility for distributing water and managing the infrastructure has been delegated to slum residents. Depending on lessons learnt from the two settlements, the utility may adopt this model to improve services in other informal settlements.

Nyalenda A has 8070 households, and a total population of 28,440; Nyalenda B has 8561 households, with a total population of 32430. Nyalenda A is more crowded than Nyalenda B, population density = 8953 residents/$km^2$; Nyalenda B population density = 6886 residents/ $km^2$ (KBNS, 2009). Together, the two settlements constitute the largest slum in Kisumu city (Karanja, 2010). Prior to the implementation of DMM, proliferation of illegal connections in the two settlements contributed significantly to KIWASCO's non-revenue water (WSP, 2009). Under DMM, the utility delivers water in bulk to four metered community master-operators in Nyalenda B. In Nyalenda A, the utility delivers water in bulk to three individual private master operators and one group master operator.

The master operators pay KIWASCO monthly for the water they have sold that month to water kiosk operators and individuals with piped connections. It is the responsibility of the master-operators to sell water to consumers through piped connections, or through a network of water kiosks and standpipes for households that cannot afford piped connections. The utility trains master operators how to establish and manage water distribution networks; this is not an easy task for lay people. A majority of households depend on water standpipes and kiosks managed by individuals. In both Nyalenda A and B, the tariffs are determined by KIWASCO in consultation with the master operators. By 2011, there were 175 individual water kiosks in Nyalenda A and 88 in Nyalenda B. The number of water kiosks has continued to increase as more people apply to open kiosks in the interior of the settlement. However, prospective kiosk operators must be able to bear the cost of materials (e.g., water meter, pipes, lease of space) and labor required to set up their kiosks (WSP, 2009). In this study, 47 individual operators from Nyalenda A and 26 from Nyalenda B were randomly selected and interviewed. The data were compared with interviews from 30 kiosk water service providers from Manyatta B, where DMM has not been implemented. Manyatta is adjacent to both Nyalenda A and Nyalenda B, and has 7808 households. It has a population of 27,952, and is more crowded than Nyalenda A or B, with a density of 10998 residents/$km^2$.Individual kiosk operators and prospective water suppliers in Manyatta are metered and settle their bills with the utility.

### 2.3.2 Data collection and sampling

KIWASCO's list of individual water-kiosk service providers was used as a sampling frame. A random sample of 103 kiosk operators was interviewed in June 2013, with 47 from Nyalenda A, 26 from Nyalenda B, and 30 from Manyatta B. The sampling design was appropriate to uncover any differences in outcomes in the two settlements where DMM has been implemented and in Manyatta, where it has not. The sample was drawn according to the proportion of kiosk operators working in each settlement. In-person interviews were conducted with the kiosk operators. Survey questions covered the socio-demographics of the respondent (age, educational attainment, marital status, gender); service management (sources of support, arrangements for kiosk space, service disruption, types of service disruption, frequency and causes of disruption); water pricing, (current price charged per 20 litre container); and accountability (revenue collection, rate of defaulting, rate of meter disconnections for unpaid bills). Three research assistants familiar with the three neighborhoods assisted in conducting the interviews.

### 2.3.3 Data analysis

The data from open-ended interview questions and other categorical data (e.g., causes of service disruption, frequency of disruptions) were summarized using percentages. For continuous variables (e.g., water pricing), both descriptive and inferential statistics were used to compare measured variables among the three settlements.

## 2.4 Results

### 2.4.1Socio-demographic Characteristics of Water Kiosk Service Providers

Table 2.1 summarizes the socio-demographic characteristics of interviewees. There were a few significant differences among the study settlements. They differed in the age of the kiosk operator and years of formal education. The differences in marital status were not statistically significant. The proportion of operators without formal education or with only primary-school education was higher in Nyalenda A and B than in Manyatta B (Table 2.1). A much higher proportion of kiosk operators in Manyatta had secondary or post-secondary education or training than in Nyalenda A

and B. The DMM implemented in Nyalenda A and B aims to provide opportunities for those in the lowest socio-economic category in the slums, so these results are not surprising.

Younger men and women constitute a larger percentage of operators in Nyalenda A and B than in Manyatta B (Table 2.1). One of the master operators in Nyalenda B is a youth group appointed by the utility. Besides managing individual connections, the youth group provides water to a network of 15 kiosks managed by individuals, and to 108 piped connections to individual households. While men dominate service provision in Manyatta B, women dominate service provision in Nyalenda A and B. This seems to reflect the success of the DMM as a pro-poor strategy that targets marginalized groups (such as slum women) to participate in service provision. The Kenya National Water Services Strategy (MWI, 2007) recognizes that slum women bear a disproportionate burden of collecting water, as well as of handling other household chores. Consequently, women suffer most when water supply is unreliable, because they are the ones who have to trek long distances in crowded, often unsafe slums to haul water. Thus, women are likely to have greater interest than men in a well-functioning urban water supply.

Low participation of women in partnerships for water supply is often blamed on the formal and informal rules insensitive to the dilemmas of poor women. For instance, a utility may require that a kiosk operator have a bank account before he or she is given a permit to operate a water standpipe or kiosk. This requirement fails to recognize that the majority of women in slums rely on their spouses or children for support and have no money of their own to put in a bank account. The requirement thus becomes a barrier to the very people the DMM aims to help. Because women are the ones responsible for doing household chores, they have to be able to balance the costs and benefits of working outside the home if they are to run a water kiosk. Even finding time and resources to travel to a utility office to process paperwork entails costs and social risks for women. For example, a woman must have someone with whom they can leave their children or their in-home small business while they make several trips to government offices to finalize the required paperwork (Meinzen-Dick and Zwarteveen, 1997). However, under the DMM

arrangement, a potential operator need only to raise sufficient capital, because the master operator does the work of purchasing water meter, pipes, and making the connections to utility water.

Table 2.1 Sociodemographic Characteristics of Interviewees

| Details | Nyalenda A N = 47 | Nyalenda B N = 26 | Manyatta B N = 30 |
|---|---|---|---|
| **Gender** | | | |
| Female (%) | 57.4 | 57.7 | 30 |
| **Age** | | | |
| 29 years or below (%) | 37.7 | 40 | 13.3 |
| 30 – 49 years (%) | 44.7 | 45 | 56.7 |
| 50 years or above (% | 19.6 | 15 | 30 |
| **Years of education** | | | |
| No formal education (%) | 14.9 | 11.5 | 0 |
| Have some primary education or has completed primary (%) | 57.4 | 84.6 | 6.7 |
| Have secondary education or higher (%) | 27.7 | 3.9 | 93.3 |
| **Marital status** | | | |
| Never married (%) | 12.6 | 7.7 | 3.3 |
| Married (%) | 74.5 | 88.5 | 93.3 |
| Separated/ widowed/divorced (%) | 12.8 | 3.8 | 3.3 |

Source: Survey data

2.4.2 Service management

2.4.2.1 Arrangements for access to water-kiosk space

Results show that in Nyalenda A and B slums, arrangements for access to water–kiosk space such arrangements are diverse, and include renting space, locating a kiosk on operator-owned space, on family-owned space, or on a friend's premises, and locating a kiosk on space owned by the municipal government (e.g., on a road reserve) (Figure 3). In Manyatta, only four arrangements were reported" renting, locating a kiosk on operator-owned space, negotiating with a friend to site a kiosk on their premises, and siting a kiosk on municipal government space In Nyalenda, the proportion of women (33.3%) renting kiosk space exceeds that of men (29%). In Manyatta, more men (28.6%) than women (22.2%) rent kiosk spaces. Surprisingly, unlike Nyalenda A and B where some operators owning water kiosks on a family's premises, there was no one for the category in Manyatta B. Siting a water kiosk on a friend's premises seems to be more prevalent in Manyatta (20%) than in Nyalenda A (9.65%), and 8.5% in Nyalenda B. Similar patterns are observable for siting water kiosks on municipal open spaces, Manyatta 20 per cent while only 4.1% in Nyalenda A and 3.8 in Nyalenda B. In particular, more women in Manyatta (22.2%) reported siting water kiosks on municipal government open spaces compared to 4.8 percent in Nyalenda.

Partnership arrangements usually leave site arrangements to prospective kiosk operators. They seem to ignore the challenges posed by the low likelihood that slum residents will own property on which to site a kiosk. Because the prevailing culture favors men in land decisions, they have an advantage over women in securing sites on which to locate a kiosk (. The higher proportion of more women than men siting water kiosks on municipal open spaces may reflect underlying problems of access to land.

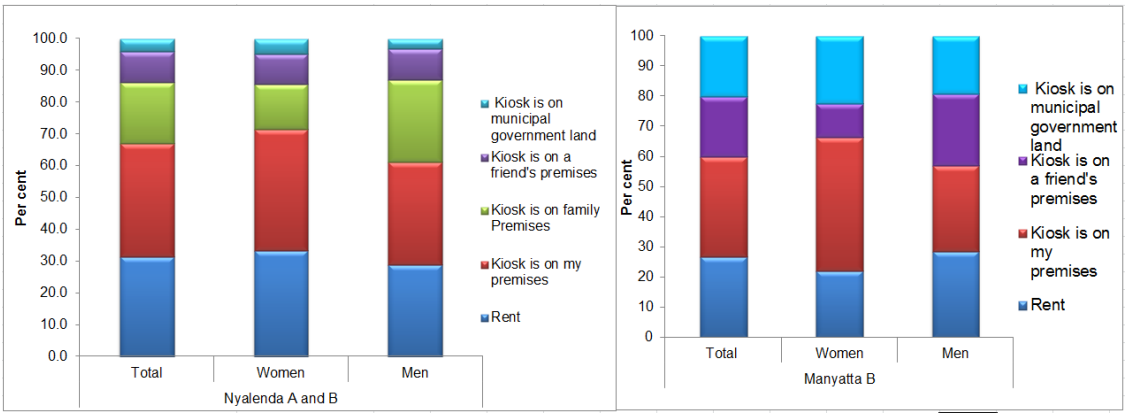


Figure 3: Kiosk space access arrangements. Source: Survey data

2.4.2.2 Start-up capital

High connection fees are often identified as a major reason why the urban poor lack access to safe water (WSP, 2009). Kiosk operators were asked how much they had spent to open their water kiosks. This is the amount that they had to pay to KIWASCO or a master operator to be connected to the utility water. Results showed that the average cost of starting a water kiosk in Manyatta was *three times* higher than in Nyalenda (Table 2.1). The lowest amount required to start water kiosk in Manyatta was 10,000 Kenyan shillings (Ksh). This is almost four times of the lowest reported by Nyalendans, Nyalenda A, 2,700 Ksh and Nyalenda B, 4,500Ksh. The average start-up capital required in Nyalenda A was 14,691.30 Ksh; in Nyalenda B it was 17507 Ksh and Manyatta it was 42623.30 Ksh. A One-way ANOVA was conducted to assess whether the differences in start-up capital were statistically significant. Results showed that the differences in were in start-up capital among the three settlements were significantly different, $F$ (2,100) = 11.80, $p < .00$, $\eta^2 = .20$. Follow-up post-hoc tests were conducted using Dunnet method with Manyatta B as the control group. Results showed that the differences in start-up capital between Manyatta and Nyalenda A, and Manyatta and Nyalenda B, were significantly different. However, differences in start-up capital between Nyalenda A and B were not statistically significant.

Kiosk operators were also asked if they had received financial support to start up their kiosks. In both Nyalenda A and B, fewer operators had received support to start (19.1% and 11.5% respectively) than Manyatta (26.7%). One goal of delegated arrangements is to lower connection fees to enable the poor to participate in water provisioning. In settlements where this arrangement is not available, the high connection fees charged by the utility may be unaffordable for most prospective kiosk operators. Those who can afford the high connection fees usually have to charge high water prices to recover high start-up costs. When water is expensive, the poor can afford less of it, and reduced access to water can have negative health consequences.

#### 2.4.2.3 Prior business experience

Respondents in both settlements were asked if they had prior business experiences. Almost an equal proportion of respondents in both settlements had prior business experience: 83.2% in Manyatta, 79.9% in Nyalenda A, and 80.8% in Nyalenda B. Most respondents reported running small businesses typical in urban informal settlements. People with small businesses seem to have diversified into selling water. Respondents reported that prior business experience helped them run a water kiosk in many ways, from having the means to raise capital, to bookkeeping, to customer relations. The delegated model aims to create jobs for the urban poor (WSP, 2009), and Schwartz & Sanga (2010) have reported one benefit of implementing DMM to be an increase in jobs created. However, my findings indicate that a large percentage of kiosk operators were already employed running their own small businesses. Therefore, the number of opportunities created for those who are unemployed is reduced.

#### 2.4.2.4 Managing service disruption

The incidence of service disruptions due to infrastructure vandalism was slightly higher in Nyalenda A than in Nyalenda B and Manyatta B (Table 2.2). Nearly twice as many kiosk operators in Nyalenda A (19.1%) had experienced meter theft than in Manyatta (10%); in Nyalenda B, it was 15.4%. Also, Nyalenda A operators also experienced more vandalism of pipes (Table 3). A One-way ANOVA was conducted to assess whether the differences in incidences of

meter theft were statistically significant. Results showed that the differences were not significantly different amongst the three settlements, $F$ (2,100) = 1.73, $p$ = .18, *observed power* = .35. Infrastructure vandalism has implications on service delivery, water quality and customer satisfaction. Also, ANOVA results showed that the incidences of vandalism of operator's water pipe were did not differ significantly among the three settlements, $F$ (2,100) = .28, p = .75, *observed power* = .09

Table 2.2: Access to Water Kiosk Space, Startup capital and Service Disruption

| **Variable** | Nyalenda A N = 47 | Nyalenda B N = 26 | Manyatta B N = 30 |
|---|---|---|---|
| **Kiosk space access arrangements** | | | |
| Renting (%) | 36.2 | 26.9 | 26.7 |
| **Start-up capital** | | | |
| Average start-up capital | 14691.48 Ksh | 17707.69 Ksh | 53466.67 Ksh |
| Median | 13000 Ksh | 20000 Ksh | 40000 Ksh |
| **Prior business experience (Yes) (%)** | 78.7 | 80.8 | 63.2 |
| **Infrastructure disruption** | | | |
| Proportion who had experienced meter disconnections (%) | 36.1 | 23.1 | 73.3 |
| Proportion who had experienced meter theft (%) | 19.1 | 15.4 | 10 |
| Proportion who had experienced vandalism of water pipes | 46.8 | 30.8 | 30 |
| Average number of reported incidences of meter theft | .40 | .38 | .20 |
| Average incidences of vandalism of water pipes | 2.40 | 2.10 | 1.80 |

Source: Survey data

2.4.3 Water pricing

Kiosk operators were asked how much they charged for water per 20 litre container. This is the standard container used by customers in many towns and cities in Kenya (UNDP, 2011). Nyalenda A and B prices were lower than Manyatta prices. On average, a 20 litre jerrrican in Nyalenda A costs 2.97 Ksh; in Nyalenda B it was 2.90 Ksh and 3.70 Ksh in Manyatta B. The lowest price in Nyalenda A and B is Ksh 2.00 same as that of Manyatta; however, the highest price in Manyatta was Ksh 5.00 compared to only Ksh 3.00 in Nyalenda. The difference in water pricing between the three settlements was statistically significant, $F(2,100) = 14.52$, $p < .001$, $\eta^2 = .23$. Results of post-hoc tests using Dunnet's method revealed that current water pricing in both Nyalenda A and B differed statistically from that charged by kiosk operators in Manyatta B proposed. However, price differences between Nyalenda A and B were not statistically significant.

To explore kiosk operator satisfaction with current pricing, operators were asked, "Do you feel like you need to adjust prices to meet operational costs?" A majority respondents in Nyalenda A (72.6%) would like to adjust prices, Nyalenda B (73%) as did a majority (60%) in Manyatta. This finding was surprising because operators in Manyatta already charge considerably higher prices than in Nyalenda. The respondents were asked what maximum price they felt they could charge. The average maximum price suggested in Nyalenda A was 4.08 Ksh: Nyalenda B was 4.05 Ksh: it was 4.20 Ksh in Nyalenda B, and 5.10 Ksh in Manyatta B. This difference was statistically significant, $F(2, 100) = 3.89$, $p < .05$, $\eta^2 = .10$. Results of post-hoc tests using Dunnet's method showed that suggested water pricing in both Nyalenda A and B differed statistically from kiosk operators in Manyatta B proposed. However, price differences between Nyalenda A and B were not statistically significant.

Water kiosks are thought to offer the urban poor more flexible payment options than utility service. The majority of slum dwellers have only intermittent sources of income and prefer to pay for water when they collect it, rather than to pay for it monthly. Kiosk operators how they preferred customers to pay for water. A majority of operators preferred customers to pay at the time of

collection; however, a few gave credit, allowing customers to pay either at the close of the day or the end of the week. No kiosks had monthly arrangements for payment. Slums are very dynamic settlements; most dwellers are in constant migration looking for opportunities and economic survival. This is one of the difficulties utilities cite as a cause of high defaulting since getting users to pay monthly bills for services is challenging. It is argued that delegating service provision to kiosk operators will increase revenue collection because providers who also dwell within the slum dwellers can keep track of water users. Respondents were also asked whether they had experienced incidences of customers defaulting payment during the last 6 months prior to survey. Customer defaulting was prevalent in both settlements, though slightly higher in Manyatta (56.7% compared to 55.3% in Nyalenda A and 53.8% in Nyalenda B). In slums where there is little or no social cohesion and/or weak institutions to report and sanction defaulters, defaulting can be impossible to eradicate.

### 2.4.4 Provider accountability

In Manyatta, 73.3% of kiosk operators reported having had their water meters disconnected for failure to pay water bills compared to only 36.2% in Nyalenda A: it was 23.1% in Nyalenda B. This is surprising given that service providers in Manyatta have leeway to charge whatever price the market will bear. Interestingly, in all the three settlements, both women renters and non-renters reported the lowest incidences of meter disconnections compared to their male counter-parts. This seems to resonate well with proposals by the government and donor agencies that encourage more women as players in partnerships for water service provision enhances reliability of service provision.

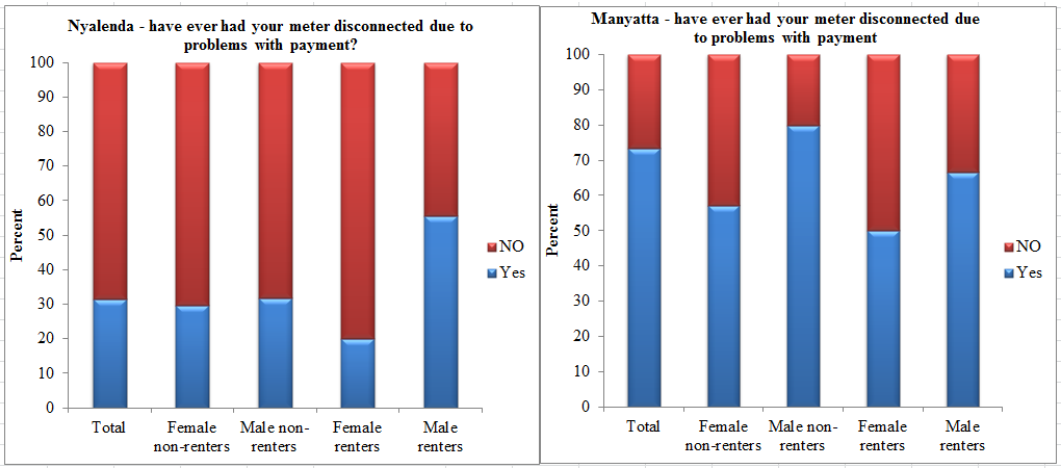


Figure 2.1: Meter disconnections incidences in Nyalenda and Manyatta (Total and comparison by gender of kiosk service provider). Source: Survey data

2.4.5 Seasonality in water kiosk customers

During the survey respondents were asked how many customers, on average, they served during dry and wet season months. Operators reported a remarkable drop in customers in all three settlements; however, the decline was greater in Nyalenda B where, on average, kiosk operators serve a relatively higher number of customers overall. The average number of customers served during the dry season, 76. dropped remarkably during rainy season to 32. In Nyalenda A, operators serveed on average 52 customers during the rainy season, this dropped 16. Manyatta operators serve an average of 54 customers a day in dry season months, and 23 during rainy season mnths. Similar trends have been reported in partnerships providing water in the small towns of Ghana (Nyarko et al., 2011). Partnerships were efffective only during the six months of dry spell, otherwise housholds reverted to collection of water from other sources during rain seasons (Nyarko et al., 2011).

## 2.5. Discussion

As Solo and others proposed, “Meeting the water and sanitation needs of poor families living in third-world urban informal settlements will require profound structural reforms that facilitate and even encourage working with existing settlements, where the greatest need for water and sanitation exists” (Solo et al., 1993, P.vi).

DMM may not be as profound a structural reform as this statement calls for, but it does involve the residents of existing informal settlements in water service as providers in formal partnership with the utility. Results of this study show that DMM has benefitted slum residents in Nyalenda. It has attracted diverse actors to provide water services, most of whom are socio-economically disadvantaged. In Manyatta, kiosk owners were less diverse. The majority of service providers in Nyalenda A and B had lower educational qualifications than those in Manyatta, and included higher proportions of younger and older people. Moreover, results showed that women constituted a higher proportion of kiosk service providers in Nyalenda A and B than in Manyatta. The relatively higher proportion of widowed or separated female operators in Nyalenda is encouraging given that in slums, women tend to have fewer resources and thus a greater need for economic opportunities to support themselves and their families (Mwobobia, 2012). In Kenya, low-income widowed or separated women tend to be looked down on (Mwobobia, 2012). The DMM has provided opportunities for these women to rise out of low status. When individuals benefit from the DMM, they acquire a stake in a functioning network, which makes them more likely to contribute to partnership success and sustainability.

DMM’s pro-poor design is partly responsible for the diversity of actors in Nyalenda A and B. DMM lightens the physical, socio-economic, and logistic burdens of starting a water kiosk. In a delegated-management arrangement, the master operators (individuals or community groups) are selected from the settlements where they live and have offices in the settlement. This solves one of the problems a prospective kiosk operator is likely to encounter: it is not difficult to contact a master operator; the kiosk operator can walk to his or her office. In Manyatta, operators have to use a taxi or public transport to get to the utility offices. In most of sub-Saharan Africa, conducting

business requires many repeat trips to official offices, and the transportation cost for repeat visits may be beyond the reach of many slum dwellers. Repeat trips also create an extra burden on women interested in opening a water kiosk, because they have to get permission from their husbands, and/or find childcare and household help in order to run errands away from home (Meinzen-Dick & Zwarteveen (1998).

Results showed that the financial burden of starting a water kiosk in Manyatta was higher than in Nyalenda A and B. DMM has lowered the costs of connection to local water lines. High connection fees are often cited as a main why reason slum dwellers cannot afford utility services (K'akumu, 2004; WSP, 2009,). In Nyalenda's DMM arrangement, master operators ensure that kiosk operators get connected once they have raised the amount required to purchase water meters and pipes. In Manyatta, a prospective kiosk operator may have to engage the services of a utility technician to purchase the meter and pipes, and also pay for pipe layout and connection fees. Such requirements prevent anyone without access to capital from engaging in the water service business. In Nyalenda A and B, once a kiosk is operating, the master operator typically conducts routine checks to monitor and repair pipe bursts and vandalism. In Manyatta, kiosk operators have to attend to these problems themselves, which often requires paying for the services of a utility or private technician. Only those with economic means can absorb such costs.

Study results also showed that customer's cost of water was lower in Nyalenda A and B than in Manyatta; the difference of one Kenyan shilling was statistically significantly. Water prices in Nyalenda are set by the master operator in collaboration with the utility. In Manyatta, kiosk operators set prices opportunistically and competitively, according to the water situation in the settlement. Kiosk operators in Nyalenda were interested in adjusting the current price per Jerrican of water; however, this has to be negotiated between the master operators and the utility. Kiosk operators in Manyatta had leeway to adjust prices opportunistically, for example when there was a service disruption and resultant shortage, they would raise prices. Water pricing affects water

accessibility, and hence, health outcomes. When water is affordable, people use more of it for cleaning and hygiene (Gleick, 1998; Hunter et al., 2010).

The study found that there was a lower incidence of provider disconnections due to unpaid water bills in the two slums where DMM had been implemented, compared to the control. Kiosk operators in Manyatta who do not pay their monthly bills are disconnected by the utility. In Nyalenda A and B, it is master operators who shut down individual kiosks. The fact that individual kiosk operators work as a network under a master operator creates collective responsibility for bill paying. If one kiosk operator is late with payments, the master operator may cover his expenses for a short time so all the operators in that network will continue to receive utility water. But if too many kiosk operators fall behind on bill payment, the master operator may not be able to cover the cost of water from the utility. Thus, there is social pressure among the kiosk operators to pay the master operator on time. Fellow kiosk operators will pressure an operator who has not paid his bills because nonpayment endangers their own operation. An interesting finding is that, in all the three settlements, women report the lower incidence of meter disconnections for nonpayment than men. This is evidence in support of the value of having more women manage water networks. Fewer disconnections of women-managed kiosks implies relatively higher reliability of services, a goal of the pro-poor DMM partnership.

While the DMM partnership delivers benefits in Nyalenda, the tendency to apply a single model of partnership as a panacea, without adequate understanding of contextual factors in the different types of informal settlements, can have unintended negative consequences. The findings revealed several challenges to attainment of all DMM goals in Kisumu, and therefore to the sustainability of the model. Kiosk providers in the three settlements reported frequent incidence of pipe burst and theft and vandalism of water meters and pipes. These incidents increase the costs of maintaining the water distribution network, and adversely affect reliability of service, quality of water, and customer satisfaction. The cost of repairs is borne by the kiosk operators, not the utility. In Nyalenda A and B, master operators are responsible for laying out the network of pipes

and connections to individual kiosks, master operators are challenged by the crowded and disorganized aggregation of dwellings in the slums. Conventional engineering practices are typically insufficient in slum areas, which are nearly always located on difficult terrain (Solo et al., 1993). Although the utility trains master operators to lay out and maintain pipe networks, the training is in no way comparable to that given to utility technicians. Expecting lay people to be able to take responsibility for technical aspects of service provision may be a weakness of DMM. The model might be improved by utility oversight of the layout of pipe networks, but such oversight would likely increase the cost of water. A stronger social network among master operators, kiosk operators, and customers could reduce theft and vandalism. Residents need to be educated to understand that they all suffer from acts of theft and vandalism of the water network infrastructure. But the incentive for collective monitoring and reporting perpetrators may be weak because law enforcement may be unreliable.

Given the challenges of terrain, crowding, and technical expertise, the utility may need to tailor the means use to deliver and distribute water in the slums to fit the existing approaches taken by independent service providers. For example, it may be more efficient to use bicycles and hand-carts to move water from service points to customers than to use piped networks. However, regulatory mechanisms would be needed to ensure that water delivered this way remains safe for drinking (Solo, 1999).

Further research is needed to explore how social organization and cohesion determine the forms of kiosk space arrangement, and how different arrangements affects service management and delivery. In neighborhoods with high social cohesion, marginalized individuals can negotiate with friends for space in which to locate a water kiosk. However, such arrangements may favor men in a culture that sees men, not women, as business owners. The study findings that a higher proportion of women site water kiosks on municipal government open spaces than on privately owned land possibly suggests an underlying problem with women's access to land. While those siting water kiosks on government land experience short-term benefits from selling water, they

are vulnerable to losing their site. It remains unclear whether government and utility officials choose to turn blind-eye to such arrangements. We also found that vandalism was higher at such sites because they tend to be located along roadsides. In the long term, siting water kiosks on government land means that, at some point, the kiosk will inevitably be dismantled, as the city seeks to make improvements or undertake development on the site. Consequently, siting water kiosks on government land will ultimately disadvantage not only kiosk operators, but also their customers.

In all the three settlement, water kiosk operators faced the challenge of seasonal water customers. Results showed a remarkable drop in the number of customers collecting water from the kiosks during the rainy season. Similar trends have been reported in Ghana for partnerships designed to provide water in the small towns (Nyarko et al., 2011). In some towns, partnerships were efffective only during the six months of the dry season (Nyarko et al., 2011). In Nyalenda, as in most slums, the majority of residents rely on casual jobs and micro-businesses to survive. Although DMM has lowered the cost of water in Nyalenda A and B, using rain water in place of kiosk water offers a huge saving. This shift to alternative water sources can reduce the incomes of kiosk and master operators substantially. It is not clear how kiosk operators cope with a sharp drop in water customers during rainy seasons, especially if the kiosk is their only source of income, as is the case for most women operators.

## 2.6 Chapter conclusion

Partnerships have been touted as promising arrangements through which to accelerate water service coverage in Sub-Saharan Africa's burgeoning informal settlements. This chapter evaluated the functioning and benefits of one such partnership arrangement, the DMM. The study advances our knowledge about the outcomes of an implemented DMM model. The study found that several benefits had been realized in the slums where DMM had been implemented; these benefits were absent in a neighboring slum where DMM had not been implemented. For example, DMM lowered the cost of water and improved provider accountability. However, water providers

in the two settlements where DMM had been implemented faced the same challenges as the control settlement in terms of burst pipes and theft and vandalism of water meters and pipes. These two findings taken together indicate that whether master operators under DMM are individuals or community groups, the outcomes of the model are the same. If water-supply systems in the slums are to improve health outcomes by reducing the incidence of water-borne illnesses, then water quality, availability (quantity), access, cost, reliability of service, and ease of managing water-distribution networks are all critical considerations (Hunter et al., 2010). DMM, as implemented in both Nyalenda settlements, improved several of these aspects of water service. But further interventions are needed to address the challenges that threaten DMM performance and sustainability if the model is to improve both water service and health outcomes in urban slums.

# CHAPTER 3

# BEYOND IMPROVED WATER SERVICE DELIVERY TO IMPROVED HYGIENIC PRACTICES: CHALLENGES OF THE DELEGATED MANAGEMENT MODEL IN KISUMU CITY, KENYA

## 3.1 Introduction

Sub-Saharan Africa is experiencing the highest rate of urbanization in the world. Growth in the region occurs in the form of proliferation of informal urban settlements (UN-Habitat, 2010). Service provision in the slums is poor, and the majority of slums dwellers lack a water supply and access to improved sanitation and solid-waste collection. Because slums are crowded and unhygienic, they are hotspots for diseases, especially those that kill children. It is estimated that informal urban settlements in Sub-Saharan Africa have among the world's highest rates of diarrheal illness caused by poor water and hygiene (WHO, 2010). The rate of child mortality from diarrheal diseases associated with poor water, sanitation, and hygiene in Kenya's towns and cities is one of the highest in the world: APHRC (2002) reports that in the country's urban slums, the infant mortality rate averages 91.3 per 1,000 children born and the under-five mortality averages 150, compared to the national averages of 73.7 and 115, respectively.

In recent years, donors and government agencies have been supporting pragmatic approaches to enhance water and sanitation service provision in the slums. Such approaches include supporting utility partnerships with slum dwellers to increase access to improved water supply. One such partnership arrangement is the delegated management model (DMM), in which the utility delegates distribution of water and management of infrastructure to slum residents. The objective of this study was to compare service provision in two settlements where DMM has been implemented and one where it has not, using water pricing, service reliability, and customer perceptions as indicators of improved access to safe water.

### 3.2 Urban water governance and impacts on the urban poor

The problem of poor access to services in Kenya's informal urban settlements is largely an institutional problem, deeply embedded on the history of the country's water sector. The origin of slums dates back to the colonial era when racial decisions controlled access to land in the urban areas. Nairobi, for instance, was a colonial city that developed as a service centre to the white-settler economy along the Mombasa-Kampala railway line (Amis, 2003). It was originally conceived as a European city where Africans were only tolerated as a source of labor for the white race (Amis, 1984). Urban water governance and development during the colonial period largely served the interests of colonists. Water service provision and infrastructure followed the residential areas settled by colonialists and ignored African squatter settlements. At the country's independence in 1963, the Kenyan government inherited water institutions that had been set up to serve colonial interests. Rather than undertake reforms and democratise colonial water institutions, the government retained them, and urban water institutions continued the colonial legacy of marginalizing informal urban settlements. Moreover, the fledging government lacked the financial, technical, and human resources required to ensure universal access to safe water (Sambu, 2011). Municipal authorities and other institutions mandated to provide service in the urban areas largely regarded slums as illegal settlements, and considered it risky to extend services to these areas (Ka'kumu, 2004).

International pressure to privatize water supply during the 1970s through 1990s further worsened matters for slum dwellers. Pressure on the state to privatize water services dominated developments in the water sector and greatly affected funding and development for urban infrastructure. Debates on the role of the private sector in water supply are not new; this has been an issue throughout the history of formal water supply systems (Baker, 2003). As Budds & McGranahan (2003) have pointed out, in the western world, the first water and sanitation services were private, and targeting the wealthier social classes who were willing and able to pay for them. However, during the nineteen century governments in the west recognized that good water and sanitation were important for both public health and national economic development, and

thus assumed the task of installing and managing piped water and water-borne sewerage systems with the goal of universal provision (Baker, 2003). The twentieth century saw these efforts institutionalized in cities and countries all over the world, with water and sewerage networks managed largely by the public sector (Budds & McGranahan, 2003). But the global south lagged behind, necessitating international efforts, especially during the 1980s (the international Drinking Water and Sanitation Decade), to accelerate provision (Sambu, 2011).

Budds & McGranahan (2003) attribute the bounce back to privatization of water supply to a shift away from statist and towards neoliberal policies in the north during the late 1970s. Under neoliberalism, global funding institutions such as the IMF and the World Bank set the agenda for international development projects, and emphasized the importance of private involvement in water supply. As Baker (2003) points out, ". . . neoliberal ideas had profound influence on international development and policy debates in the water sector in 1990s" (p. 335). This influence is reflected by the 1992 Dublin Statement which, among other things, recognized water as an economic good. This definition of water was then used to justify a shift from treating water as a public service to treating it as a good for which users should pay (Baker, 2003). A major reason why the international Drinking Water and Sanitation Decade failed to achieve universal access in low-income nations was poor cost recovery and insufficient funds to maintain water infrastructure (Sambu, 2011). Under the new water institution promoted by the IMF and World Bank, households were expected to pay the full costs of their water and sanitation services (that is, installation, operation, and maintenance). This new approach to development in water supply negatively affected the urban water sector, and especially the urban poor, who struggle to meet their most basic needs.

Reforms in Kenya's water sector in the early 2000s were informed by the international trends discussed above, and so had adverse impacts on the urban poor. Water-sector reforms in the early 2000s focused on privatizing urban water services; municipal companies were required to operate as commercial companies to achieve efficiency, revenue collection, and ensure financial

sustainability (K'akumu, 2004). Scholars have criticized Kenya's move to commercialize water service provision, contending that there were ways the government could have reformed a poor-performing water sector and increase efficiency in water services without privatizing service provision (Sammy, 2004: K'akumu, 2004; Nyangena, 2010). These scholars note the lack of evidence that privatization increases the performance of water suppliers. They further point out that privatization hurts low-income households because they are unlikely to afford commercial tariffs and are consequently likely to continue relying on cheap but unimproved sources. K'akumu (2004) has cautioned that Kenya's form of commercialization of the urban water supply will deny the poor access to this service. He cites evidence from other countries which suggests that privatization has failed to attract capital, reduce corruption, reduce tariffs, or protect the interests of the poor (K'akumu, 2004).

It has been suggested that the Kenya government could ensure that the urban poor have access to water with new institutional arrangements, for instance, social tariffs (sliding-scale rates based on ability to pay), and alternative water suppliers (K'akumu, 2004). However, given that the urban poor cannot afford private connections, they may never benefit from social tarification even if it were implemented. According to K'akumu (2004), the Kenya government could recognize and allow alternative providers. A plethora of informal suppliers provide water services in informal urban settlement. These include water vendors using trucks, animal drawn and hand carts. The quality of service from independent, informal water providers has been contested; particularly the quality and pricing of water (UNDP, 2011). However, for lack of better options, it is also recognized that informal water providers fill an important niche, by providing water to the majority of urban dwellers in low-income nations (UNDP, 2011). Unfortunately Water Services Regulatory Board (WASREB) which licenses water providers in the Kenya urban areas and towns does not recognize alternative providers. At some day, urban authorities may start enforcing efforts to rid informal settlements of informal independent water providers. According to the Kenya's Water section 56 of the Kenyan Water Act *"*No person, shall, within the limits of supply of a license (formal water supplier) provide water services to more than 20 households; or simply more than

25,000 liters of water a day for domestic purposes, or more than 100,000 liters of water a day for any purpose, except under the authority of a license*"* (p.985).

Since 2000, donor agencies and governments have begun to pay serious attention to poor access to water and other services in the slums. This is largely due to the influence of human rights advocates, who contend that access to water is a basic human right (Rogers et al., 1998), UNDESA). While the Dublin Principles (1992) casually recognized that affordability of clean water and improved sanitation was critical, it was only in 2002 that the United Nations Committee on Economic, Cultural and Social Rights issued a statement declaring that water is not merely an economic commodity, and that access to water is a human right: "The human right to water entitles everyone to sufficient, affordable, physically accessible, safe and acceptable water for personal and domestic uses" (UNDESA, 2002, p.2). Consequently, countries that have ratified the United Nations International Covenant of Economic, Social and Cultural Rights are now required to "take the necessary steps towards the progressive achievement of the right to everyone to an adequate standard of living, including access to water and sanitation" (p.2).

This requirement, however, places an enormous burden on poor governments in developing nations, especially those in the Sub-Saharan region. Rapid industrialization in China and other countries in Southeast Asia has enabled governments there to improve water and sanitation services. Sub-Saharan Africa is the only continent where rapid urbanization is characterized by massive growth in the population dependent on low-income, informal work (Cohen, 2006). That means that even if African governments ratify human rights-based obligations to improve access to water, such obligations will be impossible to meet without support from donor agencies. Water development and service provision is resource intensive in terms of infrastructure for water supply, treatment, and distribution (Brookshire & Whittington, 1993). It is inconceivable that a utility can extend services to the urban poor and remain self-sustaining without external support. Utilities face the daunting challenge of providing services affordable to the poor while also increasing efficiency in revenue collection to remain solvent (Kayaga & Smout, 2007). One of the

innovative approaches that has emerged to meet this challenge is the Delegated Management Model (DMM), in which a utility delegates management of infrastructure and service delivery to slum residents (WSP, 2009). Benefits include more affordable water services, increased water accessibility, improved quality of service, and better health outcomes. Kisumu, Kenya's largest city on Lake Victoria, has been the first to implement a large-scale DMM to improve services in Nyalenda A and B, two of the city's largest slums. Kisumu has a larger proportion of its population living in informal settlements than any other urban area in Kenya's Lake Victoria region. Development agencies are keen to draw on the Kisumu model to scale-up similar utility-community arrangements in other towns in the Lake Victoria region.

3.3 Implementing the Delegated Management Model in Kisumu city, Kenya

Nyalenda, Kisumu's largest informal settlement, has been the first beneficiary of water-service provision through a DMM. Several actors participated in DMM implementation in Nyalenda (WSP, 2009). The utility, KIWASCO and the Water Services Program – Africa (WSP-Africa), developed the model (WSP, 2009). The French Embassy in Kenya provided the funding, while WSP facilitated the project and provided the technical assistance. A French Development Agency (AFD) provided additional investment to expand water supply in the two settlements (WSP, 2009). Although the KIWASCO was able to overcome the financial huddle to implement the project, mobilizing the slums dwellers to support implementation was not easy. According to WSP (2009), " . . . identifying the most effective channels through which to communicate the benefits of DMM was a major challenge for KIWASCO and Master Operators (MOs)" (WSP, 2009, p.13). The challenges the utility faced included: i) schedule conflicts as members of the households who could make decisions were only available at home during weekends and evenings, ii) difficulties in meeting landlords because the majority live outside Nyalenda, iii) poor attendance at meetings organized through the local administration by representative communities, iv) water vendors who had previously dominated water supply declined to engage in formal meetings with the utility, and v) lack of cooperation from the utility field staff, who were spreading contradictory messages (WSP, 2009).

Other cities and towns intending to implement DMM are likely to face similar challenges. Most participatory models of urban service provision are predicated on the assumption that the poor have the time and money to attend participatory activities (Jaglin, 2002). Unfortunately, as evidenced by Kisumu's experience, slum dwellers are poor people who survive on piece jobs and /or very small businesses such as street vending. Given their preoccupation with meeting their basic survival needs, and the fast pace of life in cities, mobilizing slum dwellers to rally behind projects intended to benefit them can pose a huge challenge.

In this chapter, I compared outcomes in the two settlements where DMM has been implemented and one where it has not, by comparing water pricing, service reliability, and customer perceptions.

## 3.4 Study methods

### 3.4.1 Study area description

Kisumu is the fastest growing city in Kenya. Its population grew from 100,000 at the country's independence in 1963 to over 500,000 in 2009 (KNBS, 2009). Sixty percent of residents live in informal settlements (Schwartz, & Sanga, 2010), and slightly more than fifty percent of all Kisumu residents have access to piped water (Wagah et al., 2010). Kisumu's main source of water is Lake Victoria. Water service provision in Kisumu and other towns around Lake Victoria is the responsibility of the Lake Victoria Service Board (MWI, 2007). The Board owns most of the water assets and infrastructure that water companies lease to provide water to cities and towns. It has an agreement with Kisumu Water and Sewerage Company (KIWASCO), a water company formed in 2003, to supply water in Kisumu (Wagah et al., 2010). Nyalenda A and Nyalenda B are the first settlements to benefit from the implementation of DMM. According to the partnership arrangement, KIWASCO delivers water in bulk to metered master-operators, who can be either group-operators or individuals. The master operators pay KIWASCO for the water they have sold each month. It is the responsibility of the master-operators to then sell water to consumers through piped connections, or through a network of water kiosks and standpipes for households

who cannot afford private connections. Nyalenda B occupies 4.7 $km^2$, total population = 32,430 (total households = 8561): Nyalenda A occupies 2.5 $Km^2$, total population = 28,269 (total households = 8,070). Manyatta B occupies slightly smaller area, 2.5 $Km^2$, total population = 27,952 (households = 7,808) (KNBS, 2009).

### 3.4.2 Data Collection

#### 3.4.2.1 Interviews with water kiosk customers

Three customers were randomly selected at each kiosk sampled, and interviewed about water-collection practices, amount paid per 20-litre container, methods of payment (when and how), and perceptions about reliability of supply. Children collecting water were excluded from the survey, only adults aged above 18 years were selected to participate in the interviews.Three senior undergraduate students helped to administer the interviews and to conduct participant observations at kiosks. The students were residents of Kisumu and were very familiar with the three study sites. I trained students to conduct surveys and participant observations. The interviewers observed and recorded the number of customers in the queue, number of containers per customer, whether the containers had covers, means of transporting water once containers were filled, and the general cleanliness of the kiosk premises. A total of 216 respondents were interviewed, 110 from Nyalenda A, 76 from Nyalenda B, and 30 from Manyatta B. Questionnaires were filled out by the interviewers according to participants' answers.

The data from open-ended interview questions and other categorical data (e.g., perceptions about water kiosk services) was summarized using percentages. For continuous variables (e.g., water pricing, household expenditures for water), both descriptive and inferential statistics were used to compare measured variables among the three settlements.

3.4.2.2 Collection of water samples for microbiological analysis

Forty-six water samples were taken from various sources: eight from randomly selected water kiosks, four from water vendors, four from protected wells, four from covered wells, four from protected springs, and twenty-two from household water-storage containers. To get the household samples, every third kiosk customer interviewed was asked if they would allow us to collect a sample from their household water-storage containers for microbiological testing of the quality of drinking water. I visited the 22 households to observe water-storage practices and collect the water samples. Ten households were from Nyalenda A, eight from Nyalenda B, and four from Manyatta B. Samples were collected using a 100 Ml Whirl-Pak (Nasco, Fort Atkinson, WI) bag containing sodium thiosuphate chlorine buffer. Bags were sealed and placed in a cooler box. Samples were kept at $4^0$C in the cooler while being transported to a research laboratory at the Eldoret Water and Sewerage Company Water Analysis laboratory, Eldoret, Kenya. The morning after collection, samples were analyzed for *E. coli* by membrane filtration, using standard methods and m-ColiBlue24 broth, a nutritive membrane-filtration media that simultaneously detects total coliforms and *E.coli* within 24 hours. For each sample, 25 ml volumes were filtered and the plates incubated at 35.5 ± 0.5$^o$C for 24 hours. The bacterial counts were reported as coliform-forming units per 100ml of water (CFU/100ml). Data from test results was summarized using descriptive statistics that showed frequencies of sample contamination.

3.5 Results

3.5.1 Sociodemographic Characteristics of Respondents

Table 3.1 summarizes the sociodemographic characteristics of interviewees. The sociodemographic data collected show that the mean age of the interviewees in Nyalenda A was 29.3 (*SD* = 9.4), Nyalenda B, 28.6 (*SD* = 10.4), and 28.5 in Manyatta (*SD* = 5.1 ) (Table 3.1). Majority of interviewees were women, 80.7% in Nyalenda A, 89.3% in Nyalenda B, and 77.9% in Manyatta B. In Kenya, women bear the responsibility of collecting water, thus, this is not surprising (UNDP, 2011). 3.7% of interviewees from Nyalenda A had not formal education. There

were no significant differences in sociodemographic characteristics among the investigation areas.

Table 3.1: Socio-economic Characteristics of Sampled Respondents

| Details | Nyalenda A N = 110 | Nyalenda B N = 76 | Manyatta B N = 30 |
|---|---|---|---|
| **Age** | | | |
| Mean | 29.3 | 28.6 | 28.5 |
| **Gender** | | | |
| Female (%) | 80.7 | 89.3 | 77.9 |
| **Marital status** | | | |
| Never married (%) | 23.8 | 24.3 | 28.2 |
| Married (%) | 72.5 | 72.9 | 66.7 |
| Separated/ widowed/divorced (%) | 3.7 | 2.9 | 5.1 |
| **Years of education** | | | |
| No formal education (%) | 3.7 | 0 | 0 |
| Have some primary education or has completed primary (%) | 46.8 | 44.9 | 50 |
| Have secondary education or higher (%) | 49.6 | 55.1 | 50 |

Source: Survey data

3.5.2 Cost of water

Interview respondents were asked: i) how much they paid for water at the kiosk, ii) on average, what were their monthly expenses for water, and iii) their perceptions of the affordability of water-kiosk services. The reported average price of a 20-litre jerrican of water was Ksh 3.01 in Nyalenda B, Ksh 3.07 in Nyaleda A and Ksh 3.60 in Manyatta. This differences in pricing among the three settlement was statistically significant, $F$ (2, 213) = 14.41, $p < .01$. Results of post-hoc tests using Dunnet's method showed that showed that the difference in the amount households in Manyatta B pay compared to Nyalenda A and B was statistically significant. However, price differences between Nyalenda A and B were not statistically significant. The lowest price in both Nyalenda and Manyatta was Ksh 2.00, but the highest price in Nyalenda A and B was only Ksh 3.00, while in Manyatta it was Ksh 5.00. These findings seem to support the claims of proponents

of DMM implementation in Nyalenda (WSP, 2009) that DMM benefits the poor by driving away the “outsiders” who exploit the poor by charging high water prices (Jaglin, 2003). Water pricing has consequences on the use of water for hygiene: when people perceive the cost of water to be high, they are likely to reduce the amount of water they collect, particularly water for bathing and washing dishes and clothes, thus compromising health outcomes such as reduction of water-borne diarrheal diseases (Mintz et al., 2001).Water prices in Nyalenda A and B are set by the master operators in collaboration with the utility, while in Manyatta, kiosk operators set prices opportunistically or competitively, according to the water situation in the settlement.

The average reported monthly household expense for water in Nyalenda A was Ksh 604.73[1], Ksh 485.42 in Nyalenda B compared to Ksh 665.90 in Manyatta. The difference was statistically significant, $F$ (2, 213) = 5.12, $p < .01$, and the difference has significant implications for the urban poor. Those with low incomes are often focused on meeting basic needs, and when expenses for things like water are perceived to compete with more pressing concerns, such as paying rent, households are likely to cut down on the amount of water purchased from kiosks and rely on cheaper alternative sources to meet their water needs (Jaglin, 2002).

### 3.5.3 Reliability of service

The researcher asked respondents if they considered kiosk water services to reliable. A majority of the respondents in all settlements (81.4% in Nyalenda A, 86.7% in Nyalenda B and 93.3% in Manyatta) felt the services were not reliable. They cited burst pipe and lack of water supplied by the utility as the causes of interrupted service. In fact, on our second day of field work in Nyalenda A and B, there was no water because of an interruption of the KIWASCO main line.

[1] At the time of the study, 1US dollar = 85 Ksh. The average monthly income for slum dwellers in Kisumu is estimated to be 2500 Kshs. Although households in Nyalenda A & B spent less compared to households in Manyatta B, this is still a significant part of their income and constitutes a huge burden, especially when compared to the proportion for medium-income utility customers with piped connections who pay a much lower amount.

Customers left their containers at the stand pipes for kiosk operators to fill once services resumed. Few water kiosk owners have installed water storage tanks to cope with service disruption, and the cost of such an investment seemed beyond the reach of the majority. In the case of operators who rented kiosk premises, Lease arrangements may prevent operators who rent their kiosk premises from installing tanks. Fear of vandalism and illegal water siphoning may also discourage kiosk operators from investing in water storage tanks. A few service providers had alternative sources of water on their sites, mainly shallow wells, so that they could sell water when the utility water supply was interrupted. Water from shallow wells, protected or not, is not safe for drinking.

### 3.5.4 Household satisfaction water quantity

Questions were asked to elicit the level of customer satisfaction with the quantity of water available to meet household drinking, cooking, and hygiene needs. Respondents ranked statements according to scale of 1 = agree and 2 = disagree. The statements to be ranked were:

- I am satisfied with the quantity of water my household collects from water kiosk for drinking.
- I am satisfied with the quantity of water my household collects from water kiosk for cooking.
- I am satisfied with the quantity of water my household collects from water kiosk for bathing.
- I am satisfied with the quantity of water my household collects from water kiosk for washing clothes.

Figure 3.1 summarizes results of respondents' levels of satisfaction with quantity of water collected (percent who agreed with the statements). Nyalenda A residents were more satisfied with the amount of water available for all purposes than people in the other two settlements, but there was not that much difference in satisfaction with water available for purposes other than drinking between residents in Nyalenda B and Manyatta, except for washing clothes

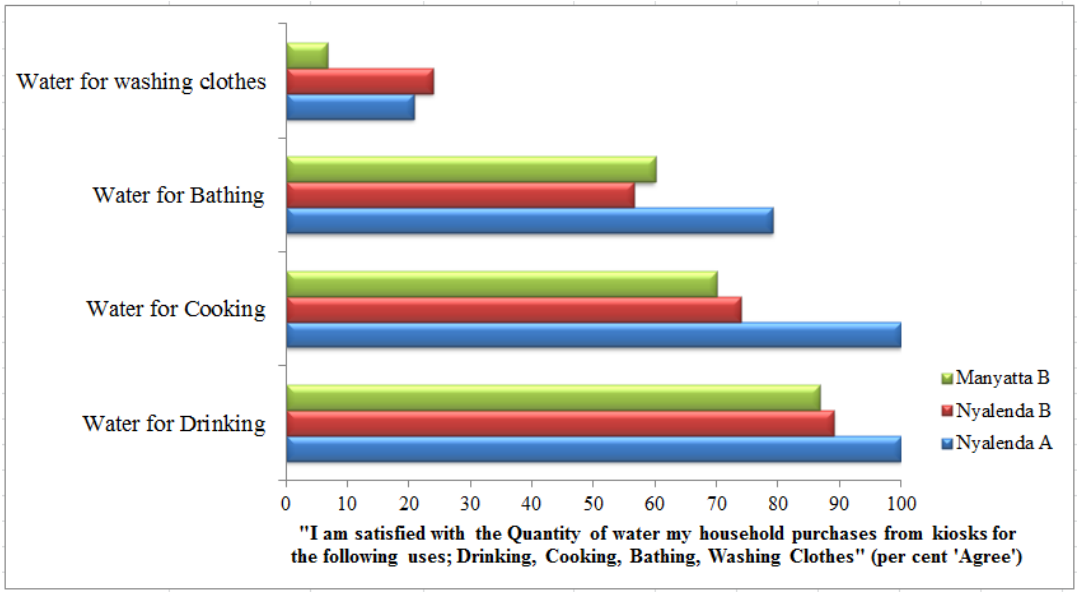


Figure 3.1: Household perceptions about sufficiency of water purchased from kiosks for drinking, cooking, and hygiene needs, by settlement. Source: Survey data.

3.5.4.1 Alternative water sources for household needs

Since the majority of respondents felt that the water they purchased from kiosks was insufficient for cooking, bathing, and washing clothes, the researcher was interested to find out where households obtained water for these uses. Results showed that Nyalenda A residents had considerably more diverse options for obtaining water for needs other than drinking (Figure 3.2). Protected wells constituted the main alternative for residents of Nyalenda A and B, while a very few households relied on a river that runs along the edge of the settlement. According to the WHO/UNICEF (2002) definitions of improved sources, covered wells, protected wells and springs can be regarded as improved sources. However, this does not necessarily mean they are *safe* sources. Alternative sources in Manyatta include privately managed covered wells and water vendors. Relying on multiple sources of water that include unsafe sources can result in cross-contamination, especially when the same containers used to collect water from kiosks for drinking are also used to collect water for other purposes from unsafe sources. The problem may persist even when households take measures to treat drinking water.

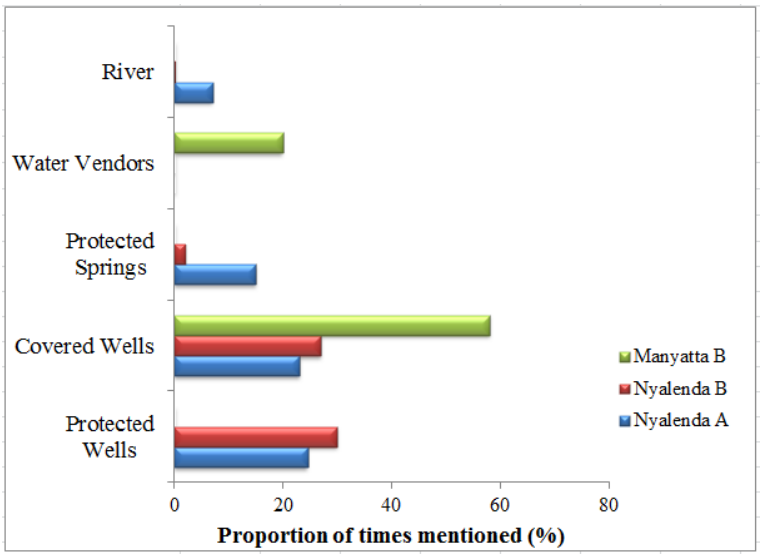

Figure 3.2: Proportion of times an alternative water source was mentioned. Source: Survey data.

3.5.5 Household perceptions of water kiosk services

The researcher asked Nyalenda A and B respondents in neighborhoods where DMM has been implemented what challenges, besides reliability; they encountered at individual water kiosks, and contrasted their reports with those from Manyatta B residents in neighborhoods where DMM has not been implemented (see Figure 3.3). In all three settlements, poor quality of water *especially* after service disruption and environmental hygiene at kiosk premises were reported as the major concerns (Figure 3.3). But we did not find any households who had switched water kiosks due to this concern. Only one household in Manyatta reported that they had complained about poor hygiene and had since noticed hygiene improvements. Switching water kiosks may be a way to communicate customer dissatisfaction and trigger action on the part of an operator; nonetheless, we found no residents who used this strategy. We asked what could be done to improve hygiene at the water kiosks. Most respondents placed the burden of action on the kiosk operator to, for instance, cement or plaster the water collection site where containers are placed, or fence sites to protect them from livestock such as pigs, which were often reported as visiting the wet sites to wallow in the mud. None of the respondents talked about the role of regulatory institutions (e.g., public health officials) in monitoring location and maintenance of kiosks sites and enforcing basic hygienic standards.

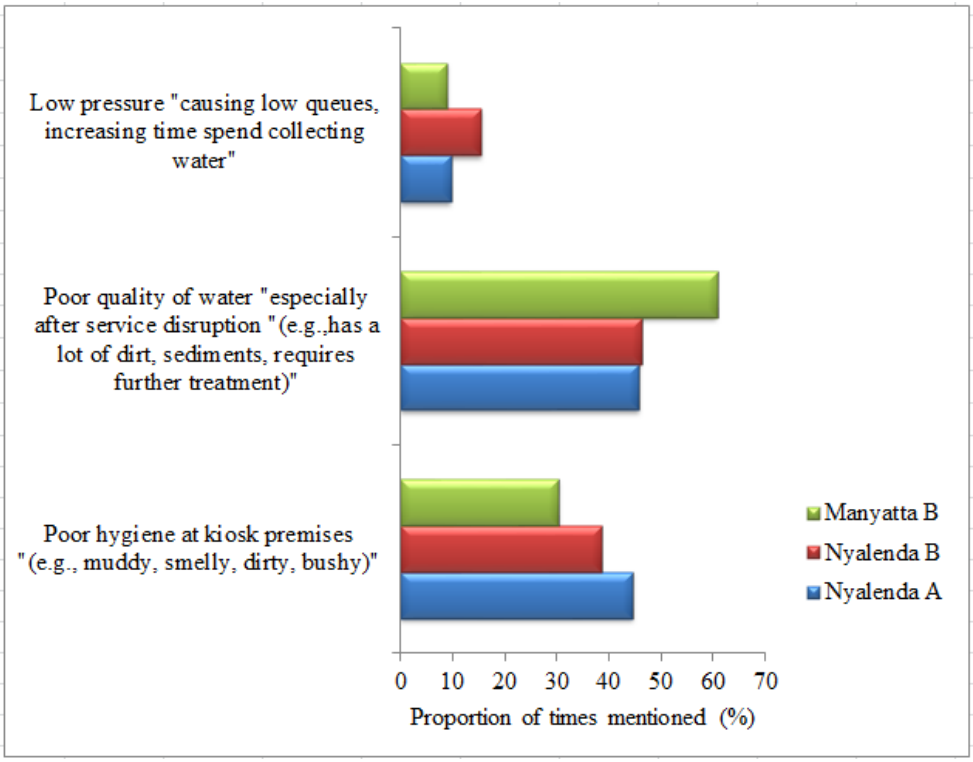

Figure 3.3: Customer concerns about water kiosk services. Source: Survey data)

3.5.6 Water collection and transport

A majority of households in the three settlements visited water kiosks daily (Table 1). The few who collected water only once a week were almost all single individuals who had formal employment. The fact that most households must collect water daily reflects their meager assets: few have enough, or large enough, storage containers to hold enough water to last for longer than one day. This limitation, which is compounded by the fact that kiosk owners lack storage tanks, leaves households vulnerable to intermittent water availability when the utility fails to deliver water to the kiosk. Differences in the number of trips among the three settlements were not significant, ($F$ (2, 213) = 1.22, $p$ = .30).

Carrying water by hand or on the head was the main means of transporting water. This was surprising because a majority of households owned either a bicycle (20.4%) or a wheelbarrow (48.1%), *none* of the households reported using these assets to help in water collection.

### 3.5.7 Household water-collection and handling practices

Most households collected water in 20-litre jerricans, which are easy to haul by hand or over the head over long distances, and are widely available from street vendors and stores. The quality varies according to place of purchase. The containers are typically recycled from previous uses, such as holding cooking oil or motor vehicle oil. Buckets were the second most popular method of collecting water. A few households used basins to collect water for washing clothes or bathing; these were typically households close to water points. Anecdotal evidence suggests that collecting drinking water with basins used for bathing or washing clothes is pervasive; it is also very unhygienic. However, the researcher did not encounter complaints about this practice from kiosk owners or customers.

In all three settlements, the majority of water-collection containers lacked lids or covers (Table 1). Only 35.9% of containers in Nyalenda A had covers, 45.9% had covers in Nyalenda B, and 49.5% had covers in Manyatta. Lack of covers or lids predisposes water to be contaminated during collection, transportation, or delivery at the households. This kind of contamination may be less prevalent when jerricans are used, because they are usually narrow mouthed (Ogutu et al., 2001).

Table 3.2: Water collection

| Variable | Nyalenda A N = 110 | Nyalenda B N = 76 | Manyatta N = 30 |
|---|---|---|---|
| **How many times a week do you come to collect water from the water kiosk?** | | | |
| Once a week (%) | 1.8 | 0.9 | 2.6 |
| Every day (%) | 87.2 | 84.1 | 79.5 |
| **In a typical day, how many trips do you make to the water kiosk?** | | | |
| Average number of trips | 3.85 | 3.51 | 3.55 |
| **Number of containers observed per customer** | | | |
| Average | 3.69 | 3.36 | 4.28 |
| **Type of water collection container** | | | |
| Jerrican (%) | 73.4 | 79.4 | 75.6 |
| Bucket (%) | 21.1 | 17.8 | 19.2 |
| Basin (%) | 5.5 | 2.8 | 5.1 |
| **Proportion of water containers that were open or closed** | | | |
| Number of containers without covers (%) | 54.1 | 50.5 | 64.1 |

3.5.8 Household handling practices: Implications on drinking water

Concerns about the quality of drinking water are widespread in Kisumu (Personal communication, Silvance Oguto). These include the high level of pollution of Lake Victoria, into which untreated and partially treated sewage is discharged (Odada et al., 2009).Given that water quality was a major concern for most respondents in this study, I was curious to find what measures households took to ensure that their drinking water was safe. Respondents were asked if they treated water, what methods they used, and what methods of storing water they used. Despite the concerns respondents expressed about quality of water, many still did not treat water at home (36.7% did not treat it in Nyalenda A, 25.2% in Nyalenda B, and 30.8% in Manyatta). I expected that a much higher proportion of households would treat their water. Those who did not treat

water cited cost as the main barrier. In all three settlements, adding chlorine (*Water Guard*) was reported to be the dominant method of household water treatment. Respondents described that this method as cheaper than boiling. This finding is consistent with those of other studies that have reported fuels used to treat water by boiling, for instance charcoal and paraffin, to be expensive (Altherr et al., 2006).

I found that a large majority of households in all settlements dipped, rather than poured, water from household containers (Table 2). Methods of drawing water from household storage containers are important because clean water can be contaminated by dipping dirty cups or hands into the container. Reducing water-borne diarrheal disease requires additional hygiene practices in the households, not just access to safe water from kiosks. Improved access may not by itself yield desired health outcomes.

Educating households to adopt safe water-storage methods has been a focus of many NGOs and government agencies attempting to reduce diarrheal illnesses in the Lake Victoria region (Ogotu et al., 2001). Most education programs have targeted rural households without access to improved water sources. The results of this study suggest that urban dwellers, particularly those in low-income settlements, are as vulnerable as rural dwellers because the methods they use to store and access water in households can contaminate safe drinking water. In this study, traditional pots were found to be the container most frequently used to store drinking water in all three settlements (Table 3.3). Traditional pots are widely used for water storage in rural and peri-urban areas of Kisumu city (which concerns development agencies), but we expected that few urban residents would use them. The use of traditional pots and other containers with wide mouths has been associated with re-contamination of drinking water (Ogotu et al., 2001). Dipping water from wide-mouthed containers with cups is one means of contamination, particularly in families with small children and/or poor hygiene practices.

Table 3.3: Household Water Treatment and Storage Practices

| Variable | Nyalenda A N = 110 | Nyalenda B N = 76 | Manyatta N = 30 |
|---|---|---|---|
| **Water treatment methods** | | | |
| None (%) | 36.7 | 25.2 | 30.8 |
| Boiling (%) | 9.2 | 15.9 | 17.9 |
| Add *water guard* (Chlorine) (%) | 54.1 | 58.9 | 51.3 |
| **Water Storage methods** | | | |
| Traditional pots (%) | 67 | 74.8 | 75.6 |
| Bucket (%) | 0 | 4.7 | 1.3 |
| Superdrum (%) | 6.4 | 2.8 | 1.3 |
| Jerrican (%) | 26.6 | 17.8 | 21.8 |
| **Methods of drawing water from storage container** | | | |
| Dipping (%) | 73.4 | 82.2 | 78.2 |
| Pouring into cup (%) | 26.6 | 17.8 | 21.8 |

3.5.9 Water analysis results

A significant finding was that no total coliforms or *E. coli* were detected in any of the eight samples from water kiosks. In contrast, all water samples from water vendors, covered wells, protected wells, and protected springs tested positive for both total coliforms and *E. coli*.

The 22 household samples tested came from a variety of storage units and treatment conditions (see Table 3.4).

Table 3.4. Distribution of Household Water Samples by Storage Unit and Treatment

| Container type | Treated | Untreated | Total | Number of samples in which total coliforms were detected | Number of samples in which *E.coli* were detected |
|---|---|---|---|---|---|
| Earthen Pot | 9 | 3 | 12 | 5 | 3 |
| Jerrican | 3 | 2 | 5 | 3 | 2 |
| Superdrum | 3 | | 3 | 3 | 0 |
| Bucket | 2 | | 2 | 0 | 0 |
| Total | 17 | 5 | 22 | 11 | 5 |

All samples from earthen pots where households had not treated water were positive for both total coliforms and *E.coli*. Seven of the water samples from earthen pots where households had treated their water were negative for total coliforms and *E.coli*, but two tested positive for both. The water samples from jerricans where households had not treated their water, tested positive for total coliforms and *E.coli,* while those from jerricans where households had treated their water tested positive for total coliforms, but negative for *E.coli*. Surprisingly, no *E.coli* was detected in samples from superdrums, but all superdrum samples tested positive for total coliforms. The samples from buckets were negative for both total coliforms and *E.coli*. The presence of indicator organisms (*Echerichia coli* or thermotolerant bacteria) in water indicates recent contamination of water sources with faecal matter and hence possible presence of intestinal pathogens. World Health Organization guidelines prescribe zero detection of *E.coli* or thermotolerant coliforms in drinking water (WHO, 2011). Water analysis results suggest that contamination of water supplies was occurring in households, especially in households that did not treat water. There are various possible explanations for the findings, e.g., because households collect water from other sources presumed to be safe when there is no water at the kiosks. Or it is possible that household members may have contaminated clean water by dipping cups in storage containers, especially when their hands were dirty. There is a high risk of contamination by household members, especially children, given the poor hygiene and sanitation conditions in the slum (Mirza, et al., 1997).

## 3.6 Discussion

The difference in water costs between Nyalenda and Manyatta was statistically significant, and this has implications for health outcomes because studies have shown that the poor will use water for hygiene only when it is affordable (Mintz et al., 2001). Nyalendan's spent less on water per month than Manyattan's, and this difference was also statistically significant. However, in terms of satisfaction with the quantity of water purchased from kiosks, Nyalenda A residents were more satisfied with the amount of water available for all purposes than people in the other two settlements, but there was not that much difference in satisfaction with water available for

purposes other than drinking between residents in Nyalenda B and Manyatta, except for washing clothes

Though not surprising, kiosk customer concerns about kiosk-site hygiene highlight the problem of attempting to improve water-service in urban informal settlements without paying attention to the structural constraints that limit utilities from extending water-distribution infrastructure into slums (Solo, 193). This raises an important question about what agencies define as “improved” service provision. Slums are crowded and often located on difficult terrain that makes it very difficult and expensive for utilities to design and build water-distribution infrastructure, either because of poor drainage or steep slopes. Providing more water points can actually *add* to existing problems of poor drainage and poor hygiene when waste-management practices are inadequate. The respondents were concerned about unhygienic delivery pipes. Kiosk operators may be reluctant to invest in better delivery pipes because they do not own the kiosk site, because the pipes are likely to be vandalized, or both. Respondents also raised concerns about the location of water kiosks next to waste dumps and toilets.

As I discussed in chapter 2, advocates of water utility-community partnerships often leave the burden of finding places to site kiosks to prospective water vendors, who are themselves poor. The agencies that promote such partnerships seem to ignore physical structural constraints and the dynamics of property ownership, both of which pose challenges, particularly to the urban poor who are expected to play roles in water distribution. These are the same individuals whom the partnership proponents aim to benefit with increased economic opportunities. The higher proportion of women than men siting water kiosks on municipal open spaces may be indicative of underlying problems of access to land. While those siting kiosks on such spaces may gain in the short-term by maximizing profits from water sales, they likely have little or no incentive whatsoever to invest in hygiene improvements. Also, while cementing water points to improve drainage was perceived by households to be an obvious way to improve kiosk hygiene, the costs of such an undertaking can be prohibitive to a poor person seeking a subsistence-level income

from water sales. Without a regulatory institution to enforce hygiene standards, the motivation to undertake such improvement is absent.

Without external regulation, the concerns and suggestions of the households may continue to go unheeded, particularly in light of the perfectly understandable motivation of kiosk operators to maximize profits from water sales. Operators are motivated to sell water to earn enough income to meet basic household needs (e.g., rent, food, school fees). They may be ignorant of, or unconcerned about, the importance of maintaining hygienic premises. We expected to hear respondents report action on their part, for instance, patronizing a more hygienically managed water kiosk. Customer actions such as changing patronage when a water kiosk owner fails maintain basic hygiene could spark remedial action on the part of kiosk owners. However, when a kiosk is located on public space, for instance a road reserve (as was the case with several kiosks we observed), any incentives to improve hygiene may be undermined by the institutional arrangements that underlie access to kiosk space. Those who run kiosks in public spaces know they are there temporarily and will eventually be evicted when the government develops the space. The strategy in these cases is to make the most money possible, without regard to hygiene concerns of customers. DMM is unlikely to realize its potential to improve health outcomes unless the architects of delegated-management service-delivery systems ensure that rules exist to govern the quality of service delivery, and that those rules are enforced. Such rules should include the maintenance of basic hygiene standards at kiosks. The downside of having the utility monitor such a requirement might be a rise in the cost of water to cover the cost of monitoring.

Requiring minimum standards for water kiosk sites may have other health benefits too. Muddy kiosks sites can be breeding sites for mosquitoes. Muddy kiosk sites coupled with clothes washing at the sites may exacerbate the problem of poor drainage in the slums, and ultimately become a significant contributor to malaria incidence. While a study by (Omumbo et al., 2005).

reported declining incidence of malaria with urbanization in the Sub-Saharan region, stagnant pools of water at kiosk sites may partly counter this trend.

The poor hygiene at kiosks may indicate that essential institutional actors have been missing from the design of utility-community partnerships. Involving public health staff and urban planners in partnership design might uncover hygiene issues and encourage holistic solutions instead of the ad-hoc strategies that emerge after the utility has implemented the water-distribution arrangement with slum communities. However, as is the case with KIWASCO in Kisumu, utilities seem to be interested mainly in reducing unaccounted-for water and to be content with *hoping* that increased water accessibility will lead to better health outcomes. But the poor hygiene at water kiosks does not bode well for the achievement of public-health policy goals, particularly given the high incidence of child-mortality attributed to poor hygiene in informal urban settlements in the slums (APHRC, 2002).

While my study provides empirical evidence that DMM benefits the urban poor by reducing the cost of water and thus household expenditures on water, the health gains in terms of reduction of water-borne diarrheal disease may be marginal. My study findings highlight the inadequacy of household hygiene in water collection and handling in both settlements with DMM: most households collected water in uncovered containers and stored it in wide-mouthed pots, practices which promote recontamination of the water. I therefore conclude that although implementing DMM service provision has increased access to safe water in Nyalenda A and B, the health gains (e.g., reducing water-borne diarrhea) may be marginal due to water-collection and -storage behavior. Other research supports this conclusion. A study in Ethiopia showed that diarrheal prevalence among small boys was associated with drinking water obtained by dipping a cup into the water-storage container, while water source and amount consumed were not significant risk factors (Teklemarian et al., 2000). A study in the slums of Cote d'Ivoire found that 1% of source water contained *E. coli,* compared to 41% of water stored in households (Dunne et al., 2001). In their investigation of risk factors for diarrheal duration, Mirza et al. (1997) found that in the slums

of Nairobi, uncovered water containers were the most significant factor influencing children's recovery from diarrhea. A study in a refugee camp in Malawi reported a 69% reduction in fecal coliform levels in water and 31% reduction in diarrhea cases when water containers were covered (Lindskog & Lundqvist, 1998).

Water-collection and -handling practices could be improved by hygiene health education. However, this may require intervention at multiple levels and by different actors. For instance, public health officials could work with kiosk owners to post hygiene messages and also talk to individuals as they come to collect water. Local clinics, public and private, could take responsibility for educating clients, particularly mothers, who visit clinics with diarrheal complaints. In addition, given that children are key actors in water collection, targeting schools with hygiene health education may be a good strategy to ensure that health messages benefit students *and* their families. Some authors have noted the importance of children as health change agents, especially in child-to-child participatory health-education models. Future studies should explore the efficacy of different education strategies, and how they might be implemented.

## 3.7 Chapter conclusion

In this chapter, I compared water-service provision in two slums in Kisumu city, Kenya where the delegated-management (DMM) partnership model has been implemented and one where it has not, using water pricing, service reliability, and customer perceptions as indicators of improved access to safe water. While DMM did make water more accessible and affordable to slum residents, the intended health outcomes of the partnership model may be at least partially compromised by poor hygiene at kiosks, and by unsafe water collection, handling, and storage practices on the part of kiosk customers. Some institutional factors have been ignored or given inadequate attention in the design of the DDM partnership in Kisumu. These include: 1) the physical challenges to infrastructure that typically characterize the marginal terrain on which slums arise, 2) the technical challenges that slum dwellers face in creating and maintaining water-distribution infrastructure, and 3) the challenges to prospective vendors posed by their extremely

limited financial resources. Because DMM is the preferred model for extension of water services to slums throughout the Lake Victoria region in Kenya, Tanzania, and Uganda, it behooves DMM proponents to make use of the invention points I have discovered and described to improve the model design before it is implemented elsewhere.

# CHAPTER 4

# THE IMPACT OF A SCHOOL-BASED HYGIENE EDUCATION INTERVENTION ON STUDENT KNOWLEDGE IN KENYA

## 4.1 Introduction

The United Nations (UN) estimates that half of the world's children (approximately 1 billion) now live in urban areas, the great majority of them in cities and towns in Africa, Asia, and Latin America (UNICEF, 2002). The majority of these children live in slums, where access to safe water, sanitation, and waste-collection services are severely lacking or nonexistent. Toilet facilities, where they exist, are typically shared among several households. Children, especially girls, may find it risky to use these toilets and prefer open defecation (Bartlett, 2003: UNICEF, 2012). Slum dwellers lack access to safe drinking water, and must rely on severely contaminated water sources (WHO, 2010). Although most towns and cities in developing nations have made progress in supplying clean water to the slums via community water points (e.g., standpipes, water kiosks), this does not necessarily mean that household drinking-water quality has improved; the majority of households that collect water from improved sources wind up consuming water that is contaminated with feces, because poverty and lack of education result in use of unsanitary water-collection and -storage practices (Mintz et al., 2001). It is estimated that 1.3 million children die every year from water-borne diarrheal disease; the vast majority are children under 5 years old (WHO, 2010). Informal urban settlements in Sub-Saharan Africa have among the world's highest rates of diarrheal illness caused by poor water and hygiene (APHRC, 2002; Garenne, 2003).

Besides causing ill health, poor water and sanitation services affect children in other ways. The majority of primary schools in slums in the Sub-Saharan Africa lack basic water and sanitation infrastructure (Mugisha, 2006). Thus, besides hauling water for domestic needs, children also carry water from home or collect it from contaminated sources to drink while they are in school. The burden of children's responsibility to collect water for their households and the water-borne illnesses children suffer are the leading causes of student absenteeism in most developing

nations (Doyle, 1995). Since the 1990s, donors and governments have increased resources to ensure that primary schools in the slums have access to improved water and sanitation infrastructure (UNICEF, 2010).

However, an increase in the incidence of hand contamination by faeces among students *following* construction of school toilets has raised concerns that building toilets is insufficient to improve health outcomes among school children (Green et al., 2012). Further interventions are needed to improve children's hygiene practices. But questions remain about how to design effective hygiene-education programs that will help schoolchildren learn about links between poor hygiene practices and poor health (Bartlett, 2003).

To help answer that question, I evaluated whether a school-based hygiene health-education intervention that combined hygiene messages with participatory water testing was more effective in improving students' knowledge of safe water-handling and hygiene practices than an intervention that relied on hygiene messages alone.

4.2 Improving water and sanitation in the slums

Lack of infrastructure, particularly toilets, has been identified as a major reason for low-enrolment of girls in primary schools (Mugisha, 2006). The Millennium Development Goal of achieving universal primary education has accelerated efforts by governments and donors to provide water and sanitation infrastructure in primary schools in the slums. These efforts have indeed increased primary-school enrollment, especially of girls (Lewin, 2009). Efforts include providing schools with a piped water supply, rainwater harvesting and storage, protection of wells, and building of toilets. But the finding that hand contamination by feces has increased among student following construction of school toilets demonstrates that health goals are still not being met; there is a need for complementary investment in hygiene education that leads to behavior changes (Saboori et al., 2011). As Carter and Howsam (1999) have cautioned, the actual health benefits

of water and sanitation infrastructure can fall short of those intended when there is limited adoption of good hygiene practices.

Water and sanitation facilities can only reduce diarrheal diseases if they are developed alongside hygiene programs (Naidoo et al., 2008). In fact, hygiene education is one of the most economically efficient ways of improving health outcomes, especially in high-density settlements where residents are at high risk of contracting diseases related to poor sanitation (Mintz et al., 2001). The majority of sub-Saharan countries have included hygiene education in school curricula. For instance, in Kenya, hygiene education begins in first grade. However, slum schools have extremely limited resources and very crowded classrooms, which together make effective teaching about hygiene almost impossible. And mounting pressure on the government to provide free primary education has led to an increase in enrolment that exceeds the human and physical-infrastructure capacities of public schools (Mugisha, 2006). Moreover, because hygiene literacy is not evaluated by the country's national examinations, teachers pay only cursory attention to the subject.

A number of approaches have been used by development agencies to increase hygiene knowledge among slum dwellers. These include Participatory Hygiene and Sanitation Transformation (PHAST), which aims to help communities identify for themselves the faecal-oral routes of disease, assess their hygiene practices, and modify or adapt their behavior accordingly (WHO, 1997a). PHAST strives to involve all members of the target community – young and old, female and male, higher and lower status—in the learning process. PHAST was originally designed for rural communities and it does not work very well in urban slums, with their high population densities and residents who are consumed with meeting basic survival needs (Naidoo et al., 2008).

It may be more cost-effective to target schools and/or clinics for interventions rather than entire slums. Several authors recommend that hygiene interventions in schools target children, and that child-to-child (CtC) approaches be considered. One school-based intervention is school health clubs, where teachers choose the activities (e.g., preventing HIV and malaria). Some scholars

have argued that child-to-child models are more beneficial than school health clubs, because children in developing countries are involved in day-to-day activities that influence the health of their families and communities (Onyango-Ouma et al., 2005; Naidoo et al., 2008). Children cook, take care of babies, attend to their sick siblings, clean house, and collect, treat, and store water.

Proponents of the child-to-child model hold that CtC is the most action-oriented, participatory health-education model (Jansen, 1997 & 2000; Simovka, 2008). CtC differs considerably from more traditional approaches to health education like the *health belief model*, a predominantly top-down approach. CtC aims to empower children and strengthen their desire to influence conditions that impact their health (Onyango-Ouma et al., 2005). CtC sees children as important agents of change who have a significant influence on the hygiene practices of their peers, families, and communities (Naidoo et al., 2008). Despite CtC's advantages, few schools in Kenya have adopted the model in their water, sanitation, and hygiene interventions. Most schools rely on school health clubs, which are usually extracurricular. Onyango-Ouma et al (2005) and Pridmore, 1997) have shown that school-based health education campaigns on water, hygiene, and sanitation behaviors are more successful when pupils are engaged in a structured and specific manner. Schools can incorporate CtC within school clubs. However, in CtC, children, not teachers, are the key participants and bearers of the hygiene messages. Key to CtC is linking intervention activities with normal children's activities—that is, linking what is done in school with what takes place in the home (e.g., collecting water, house and toilet cleaning, and other domestic chores).

4.3 The potential for school-based participatory water testing in hygiene interventions

Recent advances in water-testing technology make it possible for educators to include participatory water testing in hygiene education. Today, chromogenic enzymes (CE) can simultaneously measure presence/absence (P/A) of both total coli forms and *E. coli*; older methods (e.g., most probable numbers (MPN), membrane filtration (MF)) required up to 72 hours to produce results. CE tests provide complete data in 18-24 hours or even less when higher

numbers of coliforms/*E. coli* are present in test samples (Allen et al., 2010). Such rapid microbial methods can improve public health protection (Allen et al., 2010). Commercially available (CE) methods such as the Colilert have been developed with the operator's expertise in mind, and require minimal training to perform the tests accurately and consistently (Allen et al., 2010). The challenge is how to get these techniques into the classroom and use them to make connections between hygiene practices and water quality. Individuals or institutions with access to the techniques will need to collaborate with schools to design and implement hygiene education interventions and teach students and teachers to use the techniques (MetCalf, 2011). Thus far, efforts to use the technology for community education have been limited to demonstrations (Metcalf & Polinelli, 2005). No systematic evaluation has been conducted to evaluate the impact of the demonstrations in western Kenya, where MetCalf (2011) attempted to use the technology in community training. Strategy to engage women and children in the learning process through interactions with the technologies has been completely lacking. Community health educators and public health workers need to find ways of incorporating participatory water testing in school-based and community-based hygiene health interventions.

4.4 Use of CE water testing in an inquiry-driven participatory learning process

Colilert is a reliable method to qualitatively assess bacteriological water quality. It has been recommended as a tool for citizen science in rapid assessment and monitoring of water sources to determine which sources comply with recommended drinking-water quality standards, and which do not (Vail et al., 2003). The UN-Habitat has explored the use of this method in mapping the quality of water sources in Kisii town, Kenya (Metcalf & Stordal, 2010). However, the method has been used in Kenya only for community demonstrations, not for school-based hygiene education interventions (Metcalf & Stordal, 2010). In addition, strategies to engage women and children in the learning process through interactions with the technologies has been completely lacking. Moreover, no systematic evaluation has been conducted to evaluate the impact of the demonstrations in western Kenya, where MetCalf (2011) attempted to use the technology in community training. To the best of our knowledge, this is the first study to engage teachers and

students, in a classroom setting, in using the Colilert test to educate students about the quality of water they drink at school and at home.

Previous studies have found that a major reason why health promotion campaigns have often been ineffective in improving knowledge and changing behavior is that people perceived as external to the community organize these campaigns in a top-down fashion, with little concern for local needs, values and knowledge systems (Waterkeyn, & Cairncross, 2005). Thus, lack of trust and legitimacy of the messages are important concerns of the local people, which hinder the process of learning. To address these concerns, in our study, the first author worked closely with the teachers to integrate the water testing and hygiene modules within the existing curriculum, and enabled the teachers to take the lead in conducting the lessons. This improved chances of acceptance of the messages and also increased the likelihood that the intervention would be sustained after the researcher left. Each lesson was preceded by facilitated discussion sessions in which students were encouraged to speak and write essays on their perceptions of water, sanitation, health challenges in the community, and their own everyday struggles with coping with these problems.

Beyond other school based participatory approaches, the innovativeness of our approach lay in not just delivering science based messages to the students, but using the water testing kit as a tool to engage the students in an inquiry-driven process of discovery so that they could evaluate for themselves the validity of safe water practices. The test also enabled us to translate the scientific language of water contamination into terms that made sense to students, thus increasing the likelihood of acceptance and retention. The visual impact of seeing the color change to indicate presence of coliforms piqued the curiosity and interest of students and motivated them to learn more by themselves about the underlying causal processes. Most importantly, this helped dispel some of the mystery about microbial contamination that has been a major barrier to acceptance of hygiene practices by the general public, and more specifically traditional communities that have their own cultural beliefs about hygiene and cleanliness (Akiwumi,1998;  Cummins et al., 2010).

Experts in the field of public understanding for science have also stressed the importance of relating health promotion lessons to real life experiences and the local context (Popli, 1999; Cummins et al. 2010). In the course module we designed, we developed special exercises for students to write about their daily water collection and storage, sanitation and hygiene related activities. We then encouraged them to get water samples from the collection sources they used, relate their prior hypotheses about the safety of those sources with the test results, and reflect upon what course of action they need to take. We found that showing students the test results related to their commonly used water sources and implications of their storage practices, was much more effective in facilitating an understanding of water contamination than messages delivered through messages posted on posters or other printed material generally used for health promotion campaigns. Our approach facilitated an inquisitive and questioning attitude, which was helpful not only for our purpose of water, sanitation and hygiene promotion, but also as an important learning goal by itself for the students.

Given the above experimental design, the present study sought to answer the following questions:

i) Do participants in the intervention with hygiene messages combined with participatory water testing training exhibit greater gains in hygiene knowledge relative to students who participate in an intervention that consists of hygiene messages only?

ii) Do participants in the intervention that consists of hygiene messages combined with participatory water testing training exhibit greater retention in hygiene knowledge gained relative to students who receive intervention that consists of hygiene messages only?

## 4.5 Methodology: Intervention design and impact evaluation

### 4.5.1 Intervention design

The study used a quasi-experimental design with pre-tests and post-tests for grade six students at six primary schools. Two schools participated in an intervention comprised of health messages only, and two participated in an intervention that involved health messages and water testing. Two other schools served as a control group and did not receive any intervention at all. The study population consisted of 120 middle-school students (including the control group). The school principals gave written consent for the schools to participate. Students and their parents gave verbal consent to participate. The learning activities were based on the standard curriculum. School principals were informed about the study and invited to participate. After all schools had agreed, a drawing was held where a representative of each school drew a number indicating which intervention the school would receive. Three teachers at each school were trained to facilitate implementation of the intervention. Each school implemented the intervention independently with the first author's help. Teachers randomly selected twenty students, ten boys and ten girls, for the intervention. Once the 12-month evaluation of the interventions had been completed, all students who had participated in the study at all six schools (including the two control schools).

### 4.5.2Training materials

The hygiene education training materials were developed using resources from UNICEF (2000), Pridmore (2003), and the grade six science books that the Kenyan Government recommends for middle-school students. The materials were used with teachers in a one-day training session. The materials explained the basic facts about safe water-handling and hygiene; the different ways that drinking water gets contaminated during collection, transportation and storage; methods of treating drinking water at home; and safe methods of storing drinking water. The materials also provided basic facts about cholera symptoms and treatment, and outlined the connections between drinking water quality, sanitation, and hygiene. Teaching materials were complemented with resources that the Kenya Ministry of Education recommends for teaching about water-borne

diseases to sixth graders. The two schools that participated in hygiene education combined with water-testing, received additional packages of materials highlighting simple facts about bacteriological water-quality testing using Colilert, how the test works, the potential sources of error and ways to minimize errors, and how to interpret the results. Each teacher was provided with a copy of a guidebook with simple steps for conducting Colilert field tests with photo illustrations developed by Metcalf and Stordal (2010).

### 4.5.3 Education intervention 1: Hygiene messages only

In the hygiene-message-only schools, teachers trained students through short lectures and question-and-answer discussions. Lectures and discussion sessions focussed on various issues, such as water-borne diarrheal diseases, water supply and treatment, safe water storage, hand washing, and domestic and environmental hygiene and sanitation. Facilitators used guided questions to find out what the students already knew, to stimulate discussions, and to find solutions to problems. The presentations and discussions were supplemented by pamphlets and work sheets.

### 4.5.4 Education intervention 2: Hygiene messages combined with participatory water testing

In the intervention that combined hygiene messages with participatory water testing, teachers trained students through short lectures, group discussions, and student activities. Lectures and group activities focussed on the same issues discussed above for the hygiene-message-only interventions. In group activities, students worked in pairs to identify water, sanitation, personal, and environmental hygiene and health challenges they faced at school and at home, and then used poster presentations to share their thoughts and solutions with their classmates.

In addition, teachers gave presentations about the links between personal, domestic and environmental hygiene and the microbial quality of water. The presentations described the tests that scientists do to determine the quality of drinking water. The presentations introduced students to the Colilert method for determining the presence or absence of *E. coli* in water, as an

indicator of fecal contamination. They described how the technique works and how results of the test are interpreted.

The goal of water testings was to reinforce the hygiene messages covered during short lectures and group discussions, and to facilitate an inquiry driven process of student learning. The first author worked with teachers and students to help them collect and analyze water samples from the school's water supply, storage containers, and from the water the students brought to school for drinking. In each of the two schools, 50 samples were analysed using Colilert. For quality control, samples were collected and analysed in duplicates. In addition, we collected additional samples for analysis at the Eldoret Water and Sewerage Company laboratory.

4.5.5 Impact evaluation: Pre- and post-tests of hygiene knowledge

All student participants (including students from the two control schools) completed a standardized hygiene quiz administered by teachers one week before the interventions. A post-test was administered one week after the interventions. Questions on the post-test were similar to those in pre-test. The final post-test quizzes were administered 12 months after the interventions. The quizzes and learning activities were based on the standard curriculum. The quizzes were anonymous.

The quizzes prepared covered the following topics: causes of water-borne diarrhea, hand washing, domestic water treatment, safe water storage, and domestic and environmental hygiene and sanitation. Questions were adapted from a survey conducted by O'Reilly et al. (2008) to asses primary school students' knowledge about safe water storage and treatment. A few questions related to domestic and environmental hygiene were added to Reilly et al.'s survey. Primary-school science teachers reviewed the appropriateness of the quiz. The maximum possible score on the test was 46 points. A student response was considered wrong if it was completely irrelevant, poor if it was unclear, and correct if the answer was in line with the intervention content.

The entire study protocol was approved by the Arizona State University Institutional Review Board and the Kenya National Science and Technology Research Council.

### 4.5.6 Statistical methods for evaluation

A one-way ANOVA was conducted to compare the differences in scores between pre-test and post test (one week after the intervention), with condition as a between subjects factor. A follow-up pairwise comparison on the differences scores was done using Turkey's Honest Significant difference (HSD) to find-out which differences in mean scores were significantly different. In addition, one-way ANOVA was conducted to compare the differences in scores between post-test one week after the intervention and post-test after 12 months, to test if hygiene knowledge gained during the intervention was sustained.

## 4.6 Results

### 4.6.1 Changes in knowledge during the intervention

Table 4.1 describes the changes in knowledge at various stages of the intervention. The differences in pre-test scores were not found to be significant, $F$ (2, 117) = .179, p = .836, observed power = .08). The mean scores and standard deviation for the pre-test are as follows: Control group, mean = 28.03 (SD = 5.53), message only group, mean = 28.05 (SD = 5.84), hygiene message combined with participatory water testing, mean = 27.83 (SD = 5.46).

One week after the intervention, participants from hygiene message only group and hygiene plus participatory water testing group had significant increase in hygiene knowledge levels. However, the greatest gain in hygiene knowledge took place among the hygiene message combined with participatory water testing group (mean increase of knowledge of 12.6, $p$ = 0.00) relative to hygiene message only group (mean increase of 5.1, p = 0.00). As expected, the differences in pre- and post-test knowledge scores for the control group were not significant. Results of one-way ANOVA on the differences in scores between pre-test and posttest (one week after the

intervention), with condition as a between subjects factor were statistically significant, $F$ (2, 117) = 27.68, $p$ = 0.00, $\eta^2$ = .32.

As further shown in Table 4.1, there were generally no significant changes between post-test one week and post-test 12 months after the intervention. This suggests that the gain in hygiene knowledge by both groups during the intervention was sustained. This is consistent with the results of one-way ANOVA on the differences in scores between post-test (one-week) and post test (twelve months after the intervention), with condition as a between subjects factor, $F$ (2, 107) = 1.83, $p$ = .17, observed power = .37. Figure 4.1summarizes the distribution of mean scores of hygiene knowledge by intervention group (Hygiene messages plus participatory water testing, hygiene messages only, and control group).

Table 4.1 Mean Change in Hygiene Knowledge Test Scores over the Study Period

| Group | Difference between pre-test and post-test score after 1 week | SD | p-value | Difference between the post-test 1 week and post-test 2 score after 12 months | SD | p-value |
|---|---|---|---|---|---|---|
| Control | 1.05 | 7.68 | n.s | -1.95 | 7.62 | n.s |
| Hygiene messages only | 5.08 | 7.28 | $p <$ 0.001 | 0.45 | 7.94 | n.s |
| Hygiene messages plus participatory water testing | 12.58 | 6.03 | $p <$ 0.001 | .85 | 5.35 | n.s |

*Note:* The table shows changes in mean score on a scale of 0 – 46. Knowledge increased significantly for both intervention types relative to the control group. Changes in knowledge one week and 12 months after the interventions were not significantly different.

Pre-tests showed that the majority of participants from all six schools had *some* knowledge about the cause of water borne diarrhea and about when and how to wash their hands. However, most participants could not distinguish between safe and unsafe water sources or proper and improper methods for collection and storage of drinking water. The students who received the intervention that included water testing compared water from a clean source with water from their homes' storage containers. The testing showed that water from most home storage containers had been contaminated. Teachers were surprised to find that the water stored in school's protected wells was also contaminated. In other words, students and teachers learned that whether the water came from home or from the so-called "protected wells" at school, it was contaminated. The samples of water collected from home and school storage units that were independently analyzed at the Eldoret Water Laboratory were consistent with those tested by students with Colilert field test kits.

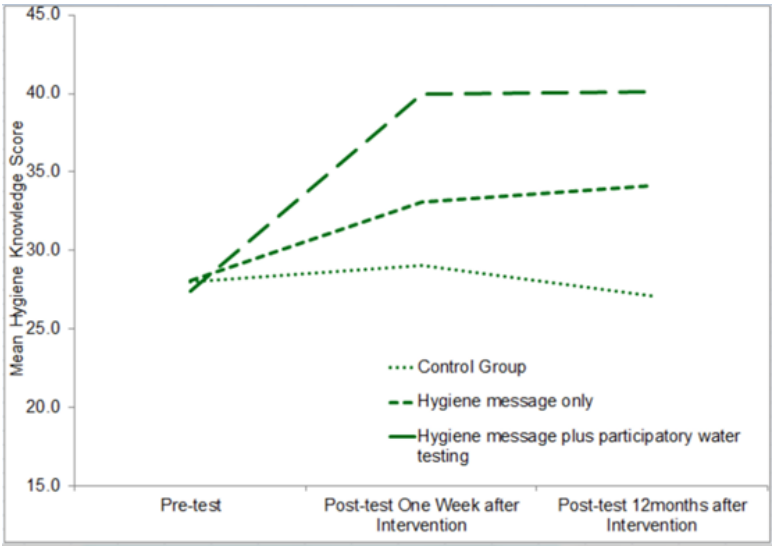


Figure 4.1. Distribution of mean scores of hygiene knowledge by intervention group (Hygiene messages plus participatory water testing, hygiene messages only, and control group).

### 4.6.2 Behavioral changes in the schools

Although there were no structured methods to observe the impact that the interventions had on the students behavior at school or at home, the researcher did notice immediate replacement of teachers' drinking storage unit from a superdrum to narrow mouthed jerrican in one of the two schools that participated in hygiene plus participatory water testing. To the surprise of teachers, results of the water testing from the storage units had tested positive for faecal coliforms. Also, in both schools that participated in the hygiene message plus water testing, the head teachers took immediate initiative to advice/warn students from collecting drinking water from rivers, open springs and wells. The schools further required students who brought water from home to school for drinking to ensure that their containers had lids, and that the water had been treated. A visit to the two schools twelve months after the intervention found one school was conducting routine checks on the quality and cleanliness of containers the students used for carrying drinking water. We did not receive reports of any changes in behavior in any of the two schools that received intervention comprised of hygiene messages only.

## 4.7 Discussion

Although promotion of safe hygiene is the single most cost-effective means of preventing water-borne diarrheal illnesses, investment in hygiene education is low in both the health and water–and-sanitation sectors (Cairncross, et al., 2010; Curtis et al., 2011). However, while it is widely recognized that hygiene education is key to improving and sustaining benefits and outcomes of water and sanitation infrastructure in primary schools, there seems to be little consensus among scholars and professionals about how to design effective interventions (Bartlett, 2003; Greene et al., 2012). The need for effective hygiene education programmes in slums is supported by the global trend to address health risks faced by children from these settlements (APHRC, 2002; Bartlett, 2003; Agarwal, & Taneja, 2005; Garenne, 2010). A recent study suggested that failure to engage students in school-based water, sanitation, and hygiene interventions in an integrated manner was the main reason why benefits and outcomes were not sustained in western Kenya (Saboori et al., 2011).

A recent UN report noted that, “the resources required to provide teaching and learning, particularly in relation to hygiene education, are frequently absent in schools. Moreover, use of creative techniques to convey the key hygiene messages are rarely part of the teacher training programme” (IRC, 2004, p.8). This study aimed to fill this gap by bringing the most current user-friendly, qualitative microbial water-testing technologies into the classroom, and ensuring that science teachers and students were able to analyze water quality. Their analyses reinforced the hygiene concepts students learned. The study was also innovative in evaluating the impact of the intervention 12 months after its implementation. As Saboori et al., (2011) pointed, monitoring school water, sanitation and hygiene (WASH) project endpoints over time for variables such as continued beneficiary use, knowledge and health is important to assess program impact, but it is rarely undertaken because of financial constraints.

The study found that participatory water testing helped both students and teachers understand that water from a clean source can be contaminated by the way it is collected, handled, and stored. Because of resource constraints, the study was unable to test whether this knowledge changed their personal hygiene or the way they collected, handled, and stored water at the households. Follow-up interviews will be needed with randomly selected sample of the parents of the children who participated in the various interventions. Where resources permit, future research should find ways of building systematic ways of investigating the impact of intervention combining hygiene messages and participatory water testing on, i) the behavior of the school children, and ii) if students who receive intervention combining messages with participatory water testing are more effective in communicating messages on safe water handling and hygienic practices than their peers who receive intervention based on hygiene messages only. If future research finds that households of students who understand the connections between hygiene practices and water handling continue to contaminate their drinking water during collection, handling, and storage, further investigation will be required to find out what are the barriers to adopting safe water-handling practices.

The study did not systematically investigate why the combination of testing and messages was more effective than messages alone in educating students and teachers about safe water, sanitation and hygiene practices. Future research could be conducted to answer this question. What matters here is that for very reasonable cost, water-testing can be included in school hygiene-education programs to improve knowledge acquisition and retention.

## 4.8 Chapter Conclusion

Hygiene education interventions that combine messages with participatory water testing produce large improvements in students' knowledge acquisition and retention. For a relatively low cost, water-testing can be included in school hygiene-education programs to improve knowledge acquisition and retention. This study demonstrates the value of a new school-based hygiene-education intervention to increase hygiene knowledge outcomes. Children can be very effective agents of change. If we focus on giving children the tools and knowledge to change their behavior today, we can prepare future generations to protect their families and communities from water-borne diarrhea. The hygiene education provided to students in this research study was ultimately expected to help students make informed decisions about water collection and storage and adopt hygiene behavior that minimizes the risks of contracting water-borne diarrhea. Collecting water is a daily chore for children in the slums. Consequently, their behavior influences their own heath and that of the people they live with. Teaching children how to avoid contaminating drinking water empowers them to make a significant impact on community health.

# CHAPTER 5

# CONCLUSION

Proliferation of informal settlements will continue to be a major phenomenon in Africa's cities and towns in the next twenty years. Utilities face enormous challenges in providing services in crowded slums. Poor water and sanitation services and challenges related to climate challenge exacerbate the already-high health risks faced by slum dwellers. Because sanitation is poor in slums, they contribute significantly to ground and surface-water pollution, affecting the very resource that cities depend on to meet the water needs of a burgeoning urban population. My research examined how slum dwellers have benefitted a new approaches to increasing access to safe water, the delegated management model (DMM), in which a utility delegates management of infrastructure and service distribution to slum dwellers.

DMM has clearly improved services and economic opportunities to slum residents. The economic opportunities it provides are especially beneficial to women and youth. The most economically vulnerable group of kiosk operators, poor women who rented premises to set up a kiosk, were the most reliable service providers from both the customer and utility perspective: they experienced the fewest disconnections for late payment of water bills. In other words, they paid their utility bills on time and therefore were able to supply water to customers reliably.

Land issues seem to be an important factor in successful kiosk operation, because the poorest operators, who did not own land and did not have the resources to lease land, often sited kiosks on municipal roadsides where they were vulnerable to vandalism and possible future demolition. If DMM is to provide economic opportunities to the poorest slum dwellers, it will have to provide them with the resources necessary to make their kiosk-location tenure secure.

The study found, not surprisingly, that lay people were not equipped to build and manage water infrastructure, especially in the difficult terrain where slums arise, despite the initial training provided by KIWASCO. The water infrastructure network was beset by problems, particularly pipe

bursts, which affected reliability of service and water quality. For DMM to realize its full potential, master and kiosk operators will need to have access to ongoing technical support from the utility or some other agency.

User perspectives are critical to the design, performance and sustainability of partnerships. When I examined user perspectives on the benefits and challenges of the implemented DMM, I found that although reported water prices were lower in the two settlements were DMM had been implemented; most respondents were dissatisfied with DMM service reliability. Therefore, the majority continued to rely on unsafe water sources to cope with service disruption. Moreover, users were more satisfied with access to drinking water under DMM than they were with access to water for other uses, such as cooking, bathing, and washing dishes and clothes. For those purposes, households continued to rely on cheaper and less improved sources, just like households in the settlements were DMM had not been implemented. Although kiosks had improved access to safe water, user water-collection methods and handling posed risks of water recontamination. Unhygienic collection and storage practices could sabotage the health benefits of DMM, for instance, reduction of water-borne diarrhea.

Hygiene education is one key to improving outcomes of water, sanitation, and hygiene interventions in the slums. Because hygiene-education approaches such as PHAST, which is aimed at entire communities, are likely to be ineffective in the slums, targeting school children may be a more efficient and cost effective approach to hygiene education in the slums. Slum children are major actors in household water supply: it is their responsibility to help collect water, treat and store water drinking water, cook, clean house, and wash clothes. I found greater improvement in schoolchildren's hygiene knowledge as a result of the intervention combining hygiene messages with participatory water testing than the intervention that relied on hygiene messages alone. Moreover, 12 months after the interventions, the students who tested had retained knowledge better than those who had not. This suggests that the slight cost and effort of including hands-on water testing in hygiene education may be well worth it. The next step in

evaluating the benefits of hands-on water testing is to evaluate whether this intervention changed children's hygiene behavior, and if not, why not.

DMM is the model most highly favored by governments and development agencies for extending slum water service in cities and towns in the Lake Victoria region in Kenya, Uganda, and Tanzania. My research findings suggest a number of steps that utilities, working with government and donor agencies, can take to improve DMM. First, other cities intending to use the model will need to adapt it to their own social and biophysical contexts. Secondly, lay people are incapable of delivering reliable water service, especially in difficult terrain. Rather than replicate the DMM exactly as implemented in Kisumu city, others cities can innovate to improve service and economic-opportunity outcomes. For example, utilities could deliver water to a variety of mobile water distributors, instead of to master operator-kiosk line extensions that keep on bursting. Using mobile water distributors would significantly reduce the costs of infrastructure creation and maintenance.

The DMM needs regulatory structures that govern the location, management, and maintenance of water points to ensure that sanitation conditions at kiosk sites meet minimum hygiene standards. The utility or a public health agency could undertake this responsibility. Regulation will need to be implemented with care to ensure that vulnerable groups, particularly poor women who earn a living by selling water, are not driven out of business. Poor women lack access to land and must lease spaces to locate kiosks. They need to be provided with the necessary incentives to improve site drainage conditions and hygiene. Most women are eager to expand their business beyond selling water to other micro-enterprises. If provided with the some monetary incentives and support from local administration to mitigate vandalism, they could invest in improving hygienic conditions and even expand to provide other goods and services that slums dwellers require, such as groceries and bathrooms.

If DMM is to achieve intended health outcomes, water quality at kiosks will have to be monitored regularly. Regular monitoring of the quality of water sold by small-scale independent providers in Peru improved services and water quality (Solo, 2002). This is an innovation that needs to be extended to DMM. Monitoring could be undertaken by a public health agency. Moreover, advances in water testing make it possible to conduct field tests and provide kiosk operators with immediate results (Allen et al., 2010). This will require governments to provide public health departments with additional resources and possibly training to ensure that personnel execute quality monitoring services.

Customers must receive encouragement at water-collection points to use safe containers for water collection and for water storage at home. Encouragement could take the form of accessible information posted at kiosks, schools, and clinics. (Accessible means that written information would be provided in ethnic languages and visual information would be available for illiterate customers). It could also take the form of providing subsidized or free safe containers for water collection and safe storage.

School-based hygiene education should include hands-on water testing by students and teachers. Since primary schools lack access to water-testing technology and teachers are not trained in effective method of teaching hygiene, individuals or institutions with access to the techniques will need to collaborate with schools to design and implement hygiene-education interventions and teach students and teachers to use the techniques.

DMM is promising but not perfect. I have identified various points at which interventions can be made to improve the model's outcomes, especially reduction of the water-borne diarrhea that kills more children in African slums than anywhere else in the world. Cities that adopt the DMM model can achieve improved outcomes by attending to these intervention points and my suggestions for changes and additions to the model.

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# APPENDIX A

## QUESTIONNAIRE FOR WATER KIOSK CUSTOMERS

1. How many times a week do you come to collect water from the water kiosk?
2. In a typical day, how many trips do you make to the water kiosk?
3. How many containers do bring on each visit to the water kiosk?
4. Who else in the household helps with water collection?

6) On a scale of 1-4, where 1 is “strongly disagree” and 4 is “strongly agree,” circle the number that best represents your feelings about the statements below.
    a) I am satisfied with the quantity of water my household collects from water kiosk for drinking.
    b) I am satisfied with the quantity of water my household collects from water kiosk for cooking.
    c) I am satisfied with the quantity of water my household collects from water kiosk for bathing.
    d) I am satisfied with the quantity of water my household collects from water kiosk for washing clothes.
7) On average, how long does a trip to the water kiosk and back take??
8) From where do you collect water when there is not water in the water kiosks?
9) What are you concerns about these other sources?
10) During the last six months, how many times did you have to collect water from the other sources you mentioned above because the water kiosk was closed?
11) What causes the disruptions in Kiosk Services?
12) What other concerns do you have related to services from this water kiosk?
13) How much do you pay for a 20-liter jerrican of water?
14) On average, in a month, how much money does your household spend on purchasing water from Kiosks or stand pipes?
15) What method of payment do you use at this water kiosk?
16) When you do not have money to pay for water, does the Kiosk Owner allow you to collect water and pay her/him later?

    If YES, how many times within the last 6 months have you paid later?

17) What do you use to store drinking water in at home?

Traditional Pot □ Jerrican □ Superdrum □ Bucket □ Other, specify

18) How do you normally draw water for drinking from the household's storage container?

a) Do you do anything to make water from the kiosk clean and safe for drinking?

b) If YES, what do you do? Boil □ Add water guard □, Other, specify

APPENDIX B

QUESTIONNAIRE FOR WATER KIOSK SERVICE PROVIDERS

1)Do you pay rent for the kiosk space?

a) Yes, rent kiosk space only

b) Yes, rent kiosk space and house

c) No, kiosk is on my own premises

d) No, kiosk located on family member's premises

e) No, kiosk is on my friend's premises

f) No, kiosk is on one of our group member's premises

g) Other, please specify

2)If you pay rent for kiosk space only, or for kiosk space and house, how much do you pay for the space/house per month?

3)Did any organizations provide you with support to start your water kiosk/stand pipe?

4) Did you have business experience prior to opening a water kiosk?

a) In what ways has your prior business experience helped you in your water kiosk services?

5)How do you rate the importance of the following sources of support for you to open a water kiosk?

6)What do you charge for a 20-liter jerrican of water?

a) What are the various ways that a customer can pay for water?

b) When is payment required?

c) Do you often feel like you need to increase the price to meet your operation costs?

d) If YES, what price do you feel you need to charge for a 20-liter jerrican of water?

e) During dry seasons, about how many people do you serve in a day?

f) During rainy seasons, about how many people do you serve in a day?

g) What do you do with customers who fail to pay for their water?

7)What are the main causes of service disruption?

- During the last 6 months, how many times did you experience some form of service disruption?
- During the last 6 months, how many times did you have to close your water kiosk because of services interruptions?
- For the period you have been operating the water kiosk, how many times have people stolen your meter?
- For the period you have been operating the water kiosk, how many times have people vandalized your water pipe or stand pipe?

8)How often have you experienced the disruptions mentioned below?

- Vandalism of your water pipe
- Vandalism of your water meter
- Pipe burst
- Meter theft

9)Since you began running your water kiosk, how many times have you had meter disconnections because you had difficulty paying the bill on time?

# APPENDIX C

## PICTURES OF HOUSEHOLDS' WATER STORAGE METHODS

Traditional water pot

Superdrum

Jerrican

Bucket